RESULTS OF THE FEASIBILITY ANALYSES PERFORMED AT INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER, TO DEVELOP OPTIMUM VALUE POLLUTION PREVENTION ALTERNATIVES

VOLUME I

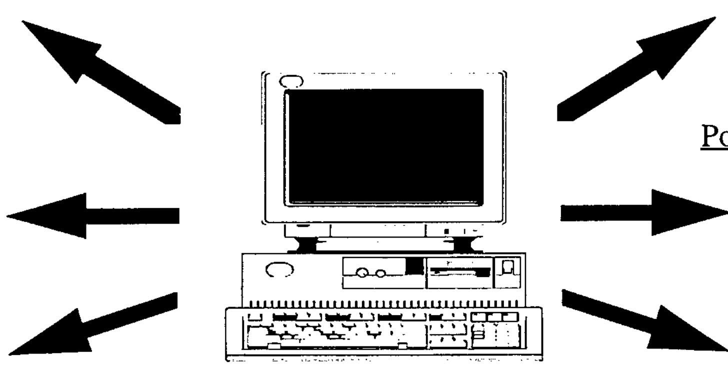
FINAL TECHNICAL REPORT

A. F. Meyer and Associates, Inc.

Pollution Prevention Priority Number Analysis

Benefit/Cost Ratio Analysis

Optimum Value Pollution Prevention Alternatives



Hazardous Substance Management System

Pollution Prevention System

1) NAVFAC P-442 Economic Analysis Model
2) Hazardous Material Substitution Process

Market Availability Studies

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Policies and procedures set forth in Executive Order 12856, OPNAVINST 5090.1B and SECNAVINST 5000.2A require the Navy to select and use the least hazardous materials to meet mission operations and maintenance needs. The Naval Supply System Command (NAVSUP), as Executive Agent for the Navy Hazardous Material Control & Management Program, is responsible for providing Navy-wide guidance for a uniform approach to the "up front" reduction of hazardous materials, consistent with engineering suitability, operational needs, and cost considerations. This Final Technical Report provides the results of on-site value engineering studies, economic and risk analyses, and market availability studies performed to identify optimum value pollution prevention alternatives for 13 status quo hazardous materials surveyed at Indian Head Division, Naval Surface Warfare Center. These feasibility analyses were performed to contribute to the maintenance of the Navy's operational readiness by reducing risks to Navy personnel, the civilian population of the environment. This technical report also provides an evaluation of the Pollution Prevention System, a PC-based management tool developed to provide guidance for reducing or eliminating hazardous materials at the source.

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FOREWORD

Policies and procedures set forth in Executive Order (EO) 12856, SECNAVINST 5000.2A and OPNAVINST 5090.1A include requirements for the Navy to select and use the least hazardous materials to meet mission, operations and maintenance needs. The Naval Supply Systems Command (NAVSUP), as Executive Agent for the Navy Hazardous Material Control and Management (HMC&M) Program, has responsibility to provide Navy-wide guidance for a uniform approach to the "up-front" reduction of hazardous materials, consistent with engineering suitability, operational needs and cost considerations.

This final Technical Report for A&E Contract No. N62470-94-D-2392, Acquisition Streamlining Program - Reduced Hazardous Waste Material Acquisition, provides the results of on-site value engineering studies, economic and risk analyses, and market availability studies, performed to develop pollution prevention alternatives for Indian Head Division, Naval Surface Warfare Center (IHD). A. F. Meyer and Associates, Inc. (AFMA) conducted site surveys at a number of shops located at IHD, collected baseline information for current methodologies, and analyzed 13 hazardous material uses, or status quo alternatives, to develop optimum value pollution prevention alternatives for recommended implementation.

This final Technical Report also includes a brief description of the tools AFMA used to identify and analyze the pollution prevention alternatives developed for implementation at IHD. AFMA utilized the Pollution Prevention (P2) System to jointly perform economic and risk analyses on both the status quo alternatives and the pollution prevention alternatives. Within this unique system, AFMA utilized the NAVFAC P-442 Economic Analysis Model, Type II economic analysis format to assist in the selection of the best pollution prevention alternatives to satisfy a current need or deficiency at IHD. Furthermore, AFMA used the P2 System to perform a risk analysis through application of the Hazardous Material (HM) Substitution Process. This methodology consists of a Substitution Algorithm, which seeks to eliminate or minimize the entry of hazardous materials into the Navy system at the earliest point in the life cycle of materials and system.

In conjunction with this, AFMA performed market availability studies to determine the availability and associated costs of each pollution prevention alternative considered for implementation at IHD. Based on the results obtained, AFMA further analyzed the most promising pollution prevention alternatives for their environmental, safety and health benefits using the Pollution Prevention Priority Number (PPPN) Analysis. Finally, AFMA performed a Benefit/Cost Ratio (BCR) Analysis on the most cost-effective, environmentally-sound pollution prevention alternatives, which are recommended for implementation at IHD, as described in this Technical Report.

AFMA conducted these analyses, as called for in the Statement of Work (SOW), in order to ensure that management controls are applied to the procurement and use of less hazardous or non-hazardous materials. The analyses performed are designed to contribute to the maintenance of the Navy's operational readiness by reducing risks to Navy personnel, the civilian population and the environment. The methodology and recommendations cited in this final Technical Report are designed to accomplish this need by identifying several optimum value pollution prevention alternatives for implementation at IHD.

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EXECUTIVE SUMMARY

PURPOSE:

This final Technical Report provides the results of the feasibility analyses performed to identify optimum value pollution prevention alternatives for 13 status quo hazardous materials identified on-site at IHD. This report also provides an evaluation of the P2 System, a unique tool representing the integration of the Hazardous Substance Management System (HSMS), the NAVFAC P-442 Economic Analysis Model and the HM Substitution Process. This system was developed to assist in conducting pollution prevention alternative assessments.

BACKGROUND:

IHD, like all Naval installations, must comply with the policies and procedures set forth in EO 12856, SECNAVINST 5000.2A, and OPNAVINST 5090.1A to select and use the least hazardous materials to meet mission, operations, and maintenance needs.

AFMA conducted site surveys and observed current methodologies at IHD. Based on the information collected on-site, AFMA performed feasibility analyses on 13 hazardous material uses. Through performance of economic and risk analyses and market availability studies, AFMA identified 79 potential pollution prevention alternatives. The 32 most promising were further analyzed using the PPPN Analysis. Finally, AFMA applied the BCR analyses to the 18 pollution prevention alternatives with the lowest PPPNs, thereby identifying the most cost-effective, environmentally-sound substitutes.

RESULTS IN BRIEF:

AFMA conducted site surveys at IHD and collected baseline information on a number of processes and hazardous material uses observed on-site. AFMA then identified several pollution prevention alternatives for comparison to this baseline situation. To do so, AFMA performed economic and risk analyses and market availability studies, and utilized the PPPN Analysis and the BCR Analysis, in order to identify the most cost-effective, environmentally-sound alternatives. Figure ES-1 presents the 11 most cost-effective, environmentally-sound substitutes, which are recommended in this Technical Report as optimum value pollution prevention alternatives for implementation at IHD.

CONCLUSIONS AND RECOMMENDATIONS:

The optimum value pollution prevention alternatives identified within this report should be considered as viable substitutes for IHD that are cost-effective and environmentally-sound. This study served as a tool for conducting future pollution prevention alternative assessments to reduce or eliminate hazardous material usage and hazardous waste generation at larger industrial-type Naval facilities. AFMA strongly believes that an initiative of this nature will aid the Navy in its mission to prevent pollution, protect the environment, and protect natural resources by eliminating or reducing pollution at the source.

	Product	Bldg.	Alternative	HMSF	UAC ($)	Initial Cost ($)	PPPN	Direct Cost Benefit ($)
	SS-4004 Silicone Primer	292	Status Quo	18	634.00	[1]	[1]	[1]
1	NONE		Proposed		-	-	-	-
	MS-143 Fluorocarbon Relesae Agent	292	Status Quo	46	612.80	0.00	-	-
2	Release #1 VOC		Proposed	23	87.62	0.00	2.0	525.18
	A-12 Parts A and B Adhesive	720	Status Quo	15/15	1,904.50	0.00	-	-
3	PSI-367 Parts A & B Epoxy Paste		Proposed	14	317.90	0.00	3.0	1,586.60
	Acetone	720, 160	Status Quo	56	586.45	0.00	-	-
4	Safety Prep, FD 080		Proposed	17	579.95	0.00	9.5	6.50
	Acetone	1040, 715	Status Quo	56	4,904.80	0.00	-	-
4	Safety Prep, FD 080		Proposed	17	5,069.80	0.00	10.5	(165.00)
	Toluene (Cleaning of Mix Bowl/Cast Tooling)	1190, 1041	Status Quo	71	3,318.08	0.00	-	-
5	Klean-Strip Mil-Klean		Proposed	28	8,013.40	0.00	20.0	(4,695.32)
	Toluene (Daily Cleanup of Mix Blades)	1190	Status Quo	71	82.66	0.00	-	-
6	Hurrisafe 9040 Special Formula		Proposed	15	152.72	0.00	20.0	(70.06)
	#1001 Zinc Primer Liquid	715	Status Quo	48	2,846.20	0.00	-	-
7	TT-E-545C Alkyd Primer		Proposed	18	2,344.60	0.00	13.0	501.60
	MIL-T-81772B Solvent Thinner	715	Status Quo	50	6,652.60	0.00	-	-
8	TT-T-291E Thinner		Proposed	23	557.80	0.00	2.0	6,094.80
	CHEMGLAZE 9951 Thinner	715	Status Quo	45	2,585.84	0.00	-	-
8	TT-T-291E Thinner		Proposed	23	557.80	0.00	2.0	2,028.04
	Thinner Synthetic Resin Enamel	715	Status Quo	41	765.40	0.00	-	-
8	TT-T-291E Thinner		Proposed	23	557.80	0.00	21.0	207.60
	Mineral Spirits	715	Status Quo	45	476.44	0.00	-	-
8	TT-T-291E Thinner		Proposed	23	557.80	0.00	24.0	(81.36)
	More than one[2]	715	Status Quo	[2]	-	-	-	-
9	Heat Resisting EN-TT-E-496A 14391		Proposed	29	3,694.60	[3]	[3]	[3]
10	A-58A Enamel (TT-E-516A)		Proposed	27	2,340.80	[3]	[3]	[3]
11	TT-E-489H Low VOC (15182 Blue)		Proposed	31	2,931.64	[3]	[3]	[3]

( ) denotes a negative value

1 - Status Quo recommended over pollution prevention alternatives based on environmental impacts

2 - More than one Status Quo sharing common Pollution Prevention Alternatives

3 - Varies depending on status quo, but each is significantly more cost effective and environmentally sound than the Status Quo

Figure ES-1
The Eleven Most Promising Pollution
Prevention Alternatives Recommended for Implementation at IHD

CHAPTER 1

INTRODUCTION AND BACKGROUND

1.0 INTRODUCTION

The on-site value engineering studies conducted, as shown in this final Technical Report, were performed to assist NAVSUP in its assigned responsibilities for management of the supply aspects of pollution prevention, and for meeting the requirements of EO 12856, of Aug 93. This EO provides emphasis for implementing aggressive actions to reduce the use of hazardous materials. In addition, these analyses were designed to support NAVSUP with its responsibility of providing guidance on incorporating HMC&M into Navy supply system acquisition programs, as required by SECNAVINST 5000.2A and OPNAVINST 4110.2. The studies also support DoD's and Congress' requirement for greater consideration for the use of commercially available materials and equipment.

Additionally, AFMA determined the feasibility of utilization of the P2 System for conducting pollution prevention alternative assessments. AFMA accomplished this task by applying the HSMS, the NAVFAC P-442 Economic Analysis Model and the HM Substitution Process to the baseline situation at IHD, as well as to the pollution prevention alternatives identified. In addition, AFMA performed market availability studies to determine the availability and associated costs of the proposed alternatives. Finally, AFMA utilized the PPPN Analysis and the BCR Analysis to ultimately identify the most cost-effective, environmentally-sound pollution prevention alternatives recommended for implementation at IHD.

1.1 Purpose of the Feasibility Analyses Conducted

The on-site value engineering studies were conducted on several hazardous material uses observed on-site at IHD. AFMA utilized the HSMS, the NAVFAC P-442 Economic Analysis Model, the HM Substitution Process, the market availability studies, the P2 System, the PPPN Analysis and the BCR Analysis for conducting pollution prevention alternative assessments. These tools provided for the identification of the optimum value solutions to pollution prevention alternatives for IHD.
This final Technical Report provides the Navy with the results of these feasibility analyses, as called for in the SOW under A&E Contract No. N62470-94-D-2392, Acquisition Streamlining Program - Reduced Hazardous Waste Material Acquisition.

1.2 Rationale for Sites Selected

In conducting the on-site value engineering studies and the feasibility analyses at IHD, AFMA critically analyzed 13 hazardous material uses at seven shops on 4 January 1996. The selection of the seven shops was based on the need to collect data representing the current baseline situation at IHD, to provide an evaluation as to the effectiveness of the HSMS, the NAVFAC P-442 Economic Analysis Model, the HM Substitution Process, the market availability studies, the P2 System, the PPPN Analysis and the BCR Analysis for developing optimum value pollution prevention alternatives.

The seven shops at which AFMA conducted site surveys are all located within IHD's Explosives Division. AFMA collected baseline information pertaining to current methodologies at the Cast Plant and Cartridge Activated Device (CAD) Rework Facilities, including:

a. Building 292 - the Cast Division, Cast Operations Division, Inert Prep Areas.
b. Building 720 - the Cast Division, Cast Operations Division, Motor Load and Rework.
c. Building 160 - the Extrusion and CAD/PAD Manufacturing Division, Operation Branch, Code 2230B2.
d. Building 1040 - the Cast Division, Cast Operations Division, Double Base Grain Area.
e. Building 715 - the Cast Division, Cast Operations Division, Double Base Grain Area.

f. Building 1190 - the Cast Division, Cast Operations Division, Warhead Cast Area and Mix and Grind Area.
g. Building 1041 - the Cast Division, Cast Operations Division, Warhead Cast Area.

1.3 Background

As called for in the SOW, AFMA identified 13 hazardous material uses at IHD and conducted on-site value engineering studies, economic analyses, risk analyses and market availability studies on each. AFMA determined that these 13 hazardous material uses would be analyzed in-depth based upon information obtained from IHD's Pollution Prevention Plan, in addition to the baseline information collected while on-site. These shops were designated as sites for the collection of baseline information for incorporation into the HSMS, the NAVFAC P-442 Economic Analysis Model, the HM Substitution Process, the market availability studies, the P2 System, the PPPN Analysis and the BCR Analysis. This baseline information was compared to similar information collected for a number of feasible pollution prevention alternatives, and the results of the feasibility analyses are presented in this final Technical Report.

1.4 Scope of Effort

This final Technical Report provides the results of the feasibility analyses conducted by AFMA, as called for in the SOW. Recommendations and comments are provided regarding the methodology and approach AFMA used, the procedures utilized, and the analyses performed. Furthermore, this report includes an explanation of the successes and problems associated with each of the steps taken, the baseline information obtained on-site, and the information collected from several sources pertaining to pollution prevention alternatives. In addition, AFMA's evaluation of the P2 System, including recommended changes and/or additions for improvement of the system as a tool for conducting pollution prevention alternative assessments, is provided. Finally, the optimum value pollution prevention alternatives recommended for implementation at IHD, based on the results of the analyses conducted, are provided.

CHAPTER 2

OVERVIEW OF THE TECHNICAL APPROACH USED TO CONDUCT THE SITE SURVEYS

2.0 EFFORTS ON-SITE

AFMA performed on-site value engineering studies on up to 15 processes or hazardous material uses currently in place at Naval installations within the Washington, DC Metropolitan area, with the ultimate goal of developing optimum value pollution prevention alternatives for each. In order to select the processes or hazardous material uses on which to perform these studies, AFMA attended a kick-off meeting with IHD representatives. This meeting familiarized those in attendance with the objectives and goals of the contract requirements, as well as the process to be utilized for identifying optimum value pollution prevention alternatives.

AFMA then conducted site surveys with IHD's Pollution Prevention Coordinator and observed processes and hazardous material uses at several shops. The processes and hazardous material uses observed were all located within the Explosives Division and the Acid Nitration Facility, and include the cleaning of tools used for mixing plastic bonded explosives; painting; manufacturing beakers; mixed acid tanks; and acid separators. The site surveys involved interviewing points of contact (POCs) at the shops in order to collect detailed information pertaining to the processes or hazardous material uses in question.

AFMA evaluated the baseline information collected while on-site, and selected the 13 hazardous material uses described in this Technical Report for further analysis. AFMA collected additional information as needed, and used this data to perform the required analyses to identify optimum value pollution prevention alternatives for the methodologies currently in place at IHD. The results of these analyses are presented in this final Technical Report.

2.1 The Kick-Off Meeting

AFMA attended a kick-off meeting at IHD on 4 January 1996 with IHD's Pollution Prevention Coordinator and a POC within the Explosives Division. At this meeting, AFMA described the work that had previously been conducted at Naval District Washington (NDW), including the successes and the problems AFMA encountered while developing optimum value pollution prevention alternatives for this Naval installation. Furthermore, AFMA explained the need to collect baseline information for those current processes and hazardous material uses which use large quantities of hazardous materials and/or generate large quantities of hazardous waste. AFMA then described each of the tools to be used for conducting the feasibility analyses, and the process by which optimum value pollution prevention alternatives would be identified and recommended for implementation at IHD.

2.2 The Site Surveys

AFMA conducted site surveys at IHD following the kick-off meeting on 4 January 1996. The purpose of the site surveys was to evaluate several processes and hazardous material uses observed at a number of shops located within the Explosives Division and the Acid Nitration Facility at IHD. While conducting these site surveys, AFMA identified and characterized existing processes, hazardous materials used and hazardous waste streams generated. AFMA utilized the checklists developed for the work completed at NDW to interview shop personnel while on-site. These checklists assisted in the collection of the baseline information necessary for inclusion into the HSMS, the NAVFAC P-442 Economic Analysis Model, the HM Substitution Process, the market availability studies, the P2 System, the PPPN Analysis and the BCR Analysis. These checklists were created from a number of sources, including EPA's Hazardous Waste Minimization Opportunity Assessment Manual, EPA's Guides to Pollution Prevention, and the Naval Energy and Environmental Support Activity's Comprehensive Hazardous Waste Minimization Survey. AFMA used these checklists to ensure that all relevant information was gathered while on-site. The completed checklists are provided in Appendix A.

Upon completion of the site surveys, AFMA organized the key pieces of information gathered on-site for each hazardous material use into a chart for reference. This list of the major hazardous material uses identified on-site at IHD highlights important data used to complete the required analyses utilizing the HSMS, the NAVFAC P-442 Economic Analysis, the HM Substitution Process, the market availability studies, the P2 System, the PPPN Analysis and the BCR Analysis (see Table 1).

2.3 Description of the Hazardous Material Uses Identified On-Site

AFMA conducted site surveys at several shops at IHD. Based on the baseline information collected on-site, as well as information obtained from IHD's Pollution Prevention Plan, AFMA selected 13 hazardous material uses to analyze in depth. These current methodologies, which are described below, are all located within the Explosives Division.

At Building 292, AFMA identified two hazardous material uses. SS-4004 Silicone Primer is applied to the endformers, baseplates and casting skirts used for casting rocket motors during Mold Assembly of MK-128 JATO. MS-143 Fluorocarbon Release Agent is applied to warheads using a spray gun during Mold Assembly of MK-128 JATO Rocket Motors. At Building 720, AFMA identified Armstrong Adhesive Parts A and B, which is used to repair damaged portions of rocket motors during the Inspection/Rework of Rocket Motors.

The use of Acetone for various purposes was observed at four shops. At Building 160, it is used for CAD Rework; at Building 720, acetone is used in the Inspection/Rework of Rocket Motors; at Building 1040, acetone is used in the Solvent Tank Cleaning of Molds and Motor Parts; and at Building 715, it is used in the Manufacture (Wrapping) of Vandal Beakers. At Building 1190, AFMA observed the use of Toluene, which has two applications, Cleaning of the Mix Bowl and Daily Cleanup of Mix Blades. The use of Toluene was also observed at Building 1041, where it is used for Cleaning of Cast Tooling.

Finally, paints, primers and thinners were analyzed for three different processes all occurring in Building 715. Miscellaneous Low VOC Paints are used in the process of Paint/Stencil/Packout Vandal Chambers. Miscellaneous Paints, Thinners and Primers are used in the process of Motor Paint, MK 37 ASROC. Miscellaneous Low VOC Paints and Primers are used in the process of Thruster Paint, MK 37 ASROC.

Table 1. List of the Major Hazardous Material Uses Identified On-Site at Indian Head Division, Naval Surface Warfare Center

	HAZARDOUS MATERIAL	MANUFACT/SUPPLIER	PROCESS	NSN	CAS NUMBER(S)	QUANTITY	EXPOSURE TIME
	BUILDING 292 Cast Plant						
1	MS-143 Fluorocarbon Release Agent	Miller-Stephenson Chemical	Mold Assembly-Application to Warheads	9150-00-F00-5302	76-13-1	0.11 gal/month	1.5 hours/week
2	SS-4004 Silicone Primer	General Electric Company	Mold Assembly-Clean/Treat Endformers	8030-00-123-6955	71-36-3; 67-64-1; 67-63-0 108-88-3; 78-10-4	0.11 gal/month	2.5 hours/week
	BUILDING 720 Cast Plant						
3	Adhesive, Parts A and B	Armstrong Products Co.	Inspection/Rework of Rocket Motors	8040-00-455-9366	N/K	0.2 gal/month	0.5 hour/week
4	Acetone	Mallinckrodt Chemical, Inc.	Inspection/Rework of Rocket Motors	6810-01-317-6090	67-64-1	0.1 gal/month	0.25 hour/week
	BUILDING 1040 Cast Plant						
5	Acetone	Mallinckrodt Chemical, Inc.	Cleaning of Molds and Motor Parts	6810-01-317-6090	67-64-1	37.5 gal/month	1 hour/week
	BUILDING 160 CAD Rework						
6	Acetone	Mallinckrodt Chemical, Inc.	Cartridge Activated Device Remanufacture	6810-01-317-6090	67-64-1	1.5 gal/month	40 hours/week
	BUILDING 1041 Cast Plant						
7	Toluene	Naval Ordinance Station	Cleaning of Cast Tooling	N/K	108-88-3	120 gal/month	1 hour/week
	BUILDING 1190 Cast Plant						
8	Toluene	Naval Ordinance Station	Cleaning of Mix Bowl	N/K	108-88-3	120 gal/month	0.25 hours/week
9	Toluene	Naval Ordinance Station	Daily Cleanup of Mix Blades	N/K	108-88-3	1 gal/month	0.25 hours/week
	BUILDING 715 Cast Plant						
10	Acetone	Mallinckrodt Chemical, Inc.	Manufacture of Vandal Beakers	6810-01-317-6090	67-64-1	40 gal/month	3 hours/week
11	Miscellaneous Paints	Various	Paint/Stencil/Packout Vandal Chambers	Various	Various	N/K	2 hours/week
12	Paint Thinner Paint Primer Polyurethane Coating, Parts 1 and 2	Various PPG Industries, Inc. Courtaulds Aerospace	Motor Paint, MK 37 ASROC	Various 8010-00-F00-0319 8010-00-181-8254	Various 7631-86-9; 14807-96-6; 1332-58-7; 107-98-2; 67-63-0; 64-17-5; 7732-18-5; 64742-89-8 7727-43-7; 13463-67-7; 68797-54-6; 108-10-1; 123-86-4;141-78-6;78-93-3	10 gal/month 10 gal/month 10 gal/month	2 hours/week 2 hours/week 2 hours/week
13	Miscellaneous Paints Miscellaneous Primers	Randolph Products Co. Randolph Products Co.	Thruster Paint, MK 37 ASROC	Various Various	Various Various	1 gal/month 1 gal/month	2 hours/week 2 hours/week

CHAPTER 3

OVERVIEW OF THE TOOLS UTILIZED TO CONDUCT THE FEASIBILITY ANALYSES AT INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER

3.0 SUMMARY OF FINDINGS

This chapter describes each of the tools highlighted in Chapter 1, which assisted AFMA in performing the on-site value engineering studies to develop optimum value pollution prevention alternatives for the 13 hazardous material uses analyzed. This chapter focuses on providing a brief explanation of these tools, each of which supported the identification of the pollution prevention alternatives recommended in this Technical Report for implementation at IHD.

3.1 The Hazardous Substance Management System (HSMS)

AFMA utilized the HSMS, a Windows compliant, menu-based application currently being tested at Naval installations, in performing the feasibility analyses. The primary objectives of the HSMS were to excel in reporting accuracy and to provide chemical usage and process data in support of reduced process and product costs. This system had the ability to track hazardous material and hazardous waste data within base operations from cradle-to-grave, while processing on an item-by-item, chemical-by-chemical, and individual transaction level basis. This system also had the capability to generate Federal environmental reports and provide information required for state and local reports.

Additionally, the HSMS maintained data for local Material Safety Data Sheets (MSDSs), and maintained material chemical constituent information, chemical hazard information, activity authorized use list (AUL) for hazardous materials, and information on all processes that use hazardous materials and/or generate hazardous waste. The system also tracked all hazardous materials ordered, received, stored, issued, used and recycled, and hazardous waste disposal. The HSMS tracked chemicals through their life cycle at the facility based on material transactions simulated, maintained an on-line hazardous material and hazardous chemical inventory, printed hazardous waste manifests and DD 1348s, and fully supported the Emergency Planning and Community Right-to-Know Act (EPCRA) requirements.

3.2 The NAVFAC P-442 Economic Analysis Model

The NAVFAC P-442 Economic Analysis Model was the analytical tool by which the circumstances affecting an investment decision at IHD were qualified and quantified to assist in the investment decision-making process. This tool systematically investigated and related all life cycle cost (LCC) and benefit implications in achieving an objective(s). It also assisted in determining the most benefits or outputs for the least resources or inputs to be expended, in order to identify the most cost-effective pollution prevention alternatives. The impacts of alternative actions were clarified by exploring all reasonable means to satisfy an objective, documenting all costs and benefits, and testing the uncertainties.

The NAVFAC P-442 Economic Analysis Model is an iterative procedure that was used to evaluate pollution prevention alternatives that meet an objective. AFMA completed each of the following six key steps in order to achieve the proper performance of this process:

1. Defined the objective by determining what is to be investigated;
2. Generated alternatives by defining all feasible alternative methods of meeting the objective, while considering all realistic alternatives;
3. Formulated assumptions, or explicit statements used to describe the present and future environments in order to reduce complex situations to problems that were manageable;
4. Determined the costs and benefits of the feasible alternatives, which required the determination of what data was needed, how this data was to be collected and documented,

and when this data was sufficiently reliable to be used in the economic analysis; in addition, this required an investigation of each alternative to determine all costs and benefits occurring during the entire project life, which is called the life cycle costing;

5. Compared costs and benefits and ranked alternatives, which required three criteria to distinguish between alternatives: least cost for a given level of effectiveness, most effectiveness for a given constraint, and largest ratio of effectiveness to cost; and
6. Performed a sensitivity analysis, which provided feedback within the economic analysis process by indicating that alternatives, estimates and assumptions were in need of further refinement.

3.3 The Hazardous Material (HM) Substitution Process

The HM Substitution Process was used to perform a risk analysis on each of the 13 hazardous material uses identified on-site, as well as on each pollution prevention alternative developed. This methodology consisted of a Substitution Algorithm, which was used to assign numerical points to potential substitute materials. Points were assigned for such factors as toxicity, duration of expected exposure to the material in question, medical effects, and a limited assessment of environmental control and impact. Information taken from the MSDSs collected on-site, provided by the manufacturers and distributors of the products being considered for implementation at IHD, and located in the Hazardous Material Information System (HMIS), was entered into the Substitution Algorithm. AFMA performed the risk analysis to identify the least hazardous, most technically-acceptable material by comparing two or more alternatives for possible implementation at IHD.

The Substitution Algorithm computed the Hazardous Material Selection Factor (HMSF) for each hazardous material use identified on-site, as well as for each pollution prevention alternative developed. The HMSF represented the final and most important indicator of a material's environmental, safety and health effects. Using the HMSF, the pollution prevention alternatives were prioritized to determine which ones will be considered for further analysis utilizing the PPPN Analysis and the BCR Analysis, and included those alternatives with the lowest HMSFs. These analyses will include a greater look at the proposed alternatives' environmental, safety and health benefits and will assist in determining which substitutes will be recommended for implementation at IHD.

3.4 The Market Availability Studies

The market availability studies were performed in conjunction with the economic and risk analyses. AFMA used these studies to determine the availability and associated costs of each of the pollution prevention alternatives developed. In conducting the market availability studies, the manufacturers and distributors of each potential substitute material were contacted to obtain the information needed to carry out this part of the feasibility analyses. This information provided AFMA with additional guidance for ranking the alternatives for possible implementation at IHD.

3.5 The Pollution Prevention (P2) System

The P2 System was the primary tool by which AFMA performed the pollution prevention alternative assessments, as called for in the SOW. This tool represented the integration of the HSMS, the NAVFAC P-442 Economic Analysis Model and the HM Substitution Process into one unique system which proved critical for conducting the most significant portion of the pollution prevention alternative assessments, the economic and risk analyses. AFMA utilized the P2 System to determine which of the pollution prevention alternatives developed would be further analyzed and ultimately recommended for implementation at IHD.

The P2 System consisted of two modules. The "System Information" Module stored information pertaining to the pollution prevention alternatives developed, including National Stock Numbers (NSNs), manufacturer names and their Commercial and Government Entity numbers (CAGEs), and MSDS-related

information such as trade names, safety and health information, physical properties and chemical constituent information. The information entered into this module was stored within the P2 System and was utilized for comparison to the status quo alternatives while conducting the economic and risk analyses.

The "Run Analyses" Module applied the information entered into the System Information Module to the NAVFAC P-442 Economic Analysis Model, both the Type I and Type II formats, and the HM Substitution Process for incorporation into the economic and risk analyses. When performing either the economic or the risk analyses from within this module, a status quo alternative was selected. This required that certain information pertaining to the status quo alternative first be entered into the Safety and Pollution Modules of the HSMS. This data was then transferred from the HSMS into the P2 System for performance of the required analyses. The P2 System allowed for the entry of missing information into the required fields, and then a pollution prevention alternative was selected for comparison to the status quo alternative. The system required the entry of specific pollution prevention alternative information into the required fields, upon which the economic and/or risk analyses were performed. The resulting output reports generated compared a status quo alternative to its applicable pollution prevention alternatives, thereby assisting in the identification of the most cost-effective, environmentally-sound alternatives for further analysis using the tools described below.

Within the P2 System, the NAVFAC P-442 Economic Analysis Model and the HM Substitution Process were independent analyses which were performed both in conjunction with one another and separately. Additionally, each unique economic and risk analysis performed within the P2 System was linked to a specific shop and/or process, based on varying information such as volumes of hazardous materials used per year and number of workers employed at each shop. However, the system did not store the resulting output reports, because new information entered into the HSMS overwrites the existing data previously uploaded to the P2 System from the HSMS, thus resulting in potentially inaccurate economic and risk analyses.

3.6 The Pollution Prevention Priority Number (PPPN) Analysis

The PPPN Analysis, which provided a pollution prevention per dollar analysis, was developed to further analyze the environmental, safety and health benefits of the pollution prevention alternatives developed. This analysis assisted AFMA in prioritizing the most promising pollution prevention alternatives, which was determined through performance of the economic and risk analyses and market availability studies, for additional study. The PPPN Analysis was utilized as a screening device for assisting with the selection of the least hazardous materials, where economically and technically feasible. The PPPN Analysis was used to ensure that the pollution prevention alternatives with the greatest environmental, safety and health benefits received the highest priority for implementation. Clearly, an alternative that will offer more pollution prevention per dollar was recommended for implementation as a prototype at IHD. The PPPN was computed by comparing the following information for each of the substitute materials proposed for implementation:

1. The HMSF from the substitution algorithm;
2. The investment cost factor (ICF) - the initial financing required to implement the recommended pollution prevention alternative, relative to the increase in environmental protection and/or safety;
3. The uniform annual cost factor (UACF) - the percent change in uniform annual cost (UAC) anticipated as a result of implementing the recommended pollution prevention alternative;
4. The weight factor (WF) - the percent change in the weight of hazardous materials anticipated as a result of implementing the recommended pollution prevention alternative; and
5. The population factor (PF) - the percent change in the number of people exposed to the process or hazardous material as a result of implementing the recommended pollution prevention alternative.

$$\mathbf{PPPN = ICF \times UACF \times WF \times PF}$$

3.7 The Benefit/Cost Ratio (BCR) Analysis

Once the PPPN was computed for each of the substitute materials being considered for implementation at IHD, those cost-effective, environmentally-sound pollution prevention alternatives with the lowest PPPNs were further tested through utilization of the BCR Analysis. This analysis was used to rate the pollution prevention alternatives in benefits versus cost terms. The BCR Analysis required the identification of all relevant inputs and outputs for translation into quantifiable costs. Costs are defined as the resources or inputs necessary to implement an alternative, and benefits are defined as the results or outputs following implementation of an alternative. AFMA considered four types of benefits while performing the BCR Analysis. These included the following:

1. Direct Cost Savings - described by one of two types:
    a. A Reduced Budget - a real cost savings, usually in the form of a reduction of recurring expenses during the projected economic life of an alternative.
    b. Self-Amortization Investment - demonstrated by a savings to investment ratio greater than one.
2. Efficiency/Productivity Outputs - represents an increase in productivity that can be measured in dollars but does not result in a reduction of the budget.
3. Other Quantifiable Outputs - stated goals defined in terms of quantifiable levels of output produced, such as productivity, quality and reliability.
4. Non-Quantifiable Outputs - benefits that are not quantifiable, but can be described qualitatively.

Those pollution prevention alternatives that provided the most results or outputs for the least resources or inputs, based upon the results of the BCR Analysis, are recommended in this Technical Report as optimum value pollution prevention alternatives for implementation at IHD.

CHAPTER 4

SUMMARY OF RESULTS AND FINDINGS

4.0 SUMMARY OF FINDINGS

This chapter presents the results of the studies performed both on- and off-site to develop and analyze 79 pollution prevention alternatives for the 13 status quo alternatives identified on-site at IHD. This chapter describes each of the steps AFMA took to identify those optimum value pollution prevention alternatives which are recommended in this Technical Report for implementation at IHD. Finally, this chapter includes documentation regarding the assumptions made and problem areas encountered while performing the feasibility analyses.

4.1 The Hazardous Substance Management System (HSMS)

As previously called for in the SOW, AFMA provided an evaluation of the HSMS and its ability to conduct pollution prevention alternative assessments at Naval installations. To test this, AFMA simulated material transactions with the baseline information collected on-site at NDW. In doing so, AFMA determined that the system is basically a tracking tool for hazardous materials and hazardous wastes, and that it cannot be used alone as a mechanism for conducting pollution prevention alternative assessments. However, used in conjunction with the NAVFAC P-442 Economic Analysis Model and the HM Substitution Process, the HSMS was capable of performing economic and risk analyses in order to identify the most cost-effective, environmentally-sound pollution prevention alternatives for implementation at Naval installations (see Section 4.7). In preparation for these economic and risk analyses, AFMA entered the baseline information collected on-site at IHD into the HSMS.

4.2 Assumptions Made While Performing the NAVFAC P-442 Economic Analysis Model, Type II Net Present Value Economic Analysis Format

Due to the nature of operations at IHD and the limited amount of cost data collected, AFMA made a number of assumptions in order to utilize the NAVFAC P-442 Economic Analysis Model, Type II economic analysis format. While these assumptions ultimately affected AFMA's performance of this analysis and should be noted when considering the overall results, the analysis was performed uniformly for each material and therefore the results were consistently accurate. The assumptions AFMA made while utilizing the NAVFAC P-442 Economic Analysis Model, Type II economic analysis format included the following:

a. The economic life of all materials was assumed to be ten years and the standard risk free interest rate was assumed to be 7.00% (taken from IHD's Pollution Prevention Plan).
b. If two or more types of personal protective equipment (PPE) were required for protection, the less or least expensive PPE was selected; for example, plastic goggles were selected when either plastic goggles and safety glasses were required as adequate protection.
c. When calculating PPE costs, AFMA did not factor the price of hats, boots and coveralls into the total cost because this was standard clothing worn by all employees working in the Explosives Division at IHD.
d. When calculating PPE costs, AFMA factored respirator costs into the total costs when recommended or required, because all of the shops at which the site surveys were conducted were poorly ventilated.
e. When gloves were required PPE, but no certain type was specified, AFMA utilized prices for solvent impermeable gloves, which were the cheapest of the four types of gloves factored into the analysis.
f. When determining PPE assumptions and costs (see Appendix B, Figure B-1), all total PPE costs were calculated for one person for one year.

g. Due to the capabilities of the P2 System, shipping fees, where applicable, were factored into the material annual costs.
h. Due to the nature of pollution prevention alternatives considered for implementation at IHD, which are all material substitutes, AFMA assumed that training costs, labor costs, and disposal costs would essentially remain unchanged.

4.3 The NAVFAC P-442 Economic Analysis Model, Type II Net Present Value Economic Analysis Format

In using the NAVFAC P-442 Economic Analysis Model to perform the economic analysis, AFMA followed a Type II economic analysis format, which was appropriate when considering material substitutions. The Type II economic analysis format was used to determine which of several pollution prevention alternatives would most economically satisfy an unmet need. This type of analysis did not concern itself with the justification of the requirement, it was concerned with the selection of the best alternatives to satisfy a need or deficiency. There were three methods of comparison available to use when performing the Type II economic analysis format. AFMA utilized the Net Present Value (NPV) Comparison because the pollution prevention alternatives being considered for implementation at IHD had the same economic lives and equal or no lead times. Lead time is the period between the initial investment for a project and the time it becomes operational.

AFMA utilized the baseline procurement and shipping information collected on-site for application to the Type II economic analysis format. With regard to the pollution prevention alternatives developed, AFMA obtained similar information from several manufacturers and distributors contacted during the performance of the market availability studies (see Section 4.6). AFMA utilized the US General Services Administration (GSA) Spring 1996 Supply Catalog as an additional source of information. The purpose of this was to determine if the pollution prevention alternatives identified were economically feasible for consideration at IHD.

The other factor available for consideration for utilization of the NAVFAC P-442 Economic Analysis Model was the total price of the PPE required for each material currently in use at IHD, and for each pollution prevention alternative developed. The PPE requirements were found on the MSDSs for each product. Appendix B, Figure B-1 lists the PPE requirements for the status quo and pollution prevention alternatives, and outlines the assumptions AFMA made with regard to quantity of PPE worn by one employee for one year, along with their associated costs. This chart was effectively used to compare the PPE costs of the status quo alternatives currently in use at IHD with the PPE costs of their pollution prevention alternatives.

With this cost information, AFMA utilized the P2 System to perform the economic analysis (see Section 4.7). This system incorporated a 4.14 discount factor into the Type II economic analysis format. This figure was taken from a table in Appendix C of the NAVFAC P-442 Economic Analysis Handbook, and takes into account the aforementioned 7.00% interest rate and ten year economic life. The results of the NAVFAC P-442 Economic Analysis Model, Type II NPV economic analysis format are presented in Appendix B, Figure B-2.

4.4 Assumptions Made While Using the HM Substitution Process to Perform the Risk Analysis

A number of assumptions were made in order to utilize the HM Substitution Process for performing the risk analyses, as required in the SOW. These assumptions ultimately affected the HMSF scores for each of the materials analyzed and should be noted when considering the overall results. However, the analysis for each material was performed uniformly and therefore the results were consistently accurate. The assumptions AFMA made while utilizing the HM Substitution Process included the following:

a. Non-hazardous materials did not have exposure restrictions and AFMA therefore assigned a zero to these materials' exposure restriction scores.
b. Because the materials identified on-site were generally used in poorly-ventilated areas, AFMA estimated the medical effects to be on the high side.
c. AFMA only considered PPE that was required, not recommended (with the exception of respiratory protection), in calculating the HMSF.
d. When a range for flash point and boiling point was reported on the MSDSs, AFMA used the lowest temperature provided to calculate the HMSF, giving the worst case scenario for the Flammable Combustible Liquid Points.
e. While completing the HM Substitution Algorithm Worksheets utilizing the P2 System (see Section 4.7), AFMA responded "No" when asked if each material being analyzed was located on IHD's AUL. The worksheets were completed as such because IHD is currently in the process of completing its AULs, and therefore this information was unavailable at the time the analyses were conducted.

4.5 The Hazardous Material (HM) Substitution Process

AFMA applied the HM Substitution Process, through utilization of the P2 System, to perform a risk analysis on the hazardous material uses identified and on their potential pollution prevention alternatives (see Section 4.7). This methodology consisted of a Substitution Algorithm, which AFMA used as a screening device for ranking the existing and proposed materials by their properties affecting the environment, safety and health. A precise interpretation of the MSDSs obtained from the manufacturers contacted was essential for accurately using the Algorithm as a tool in the material substitution process. Furthermore, the National Institute for Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards and the Environmental Protection Agency's (EPA) Title III List of Lists provided the additional information necessary for using the Algorithm.

AFMA used the HM Substitution Process to compute the HMSF, the most important indicator of a material's environmental, safety and health effects. AFMA computed the HMSF for the 13 status quo alternatives identified on-site and for each of the pollution prevention alternatives developed. The most promising alternatives were then further analyzed in terms of their environmental, safety and health benefits, based on the HMSFs calculated (see Section 4-8). AFMA's goal in using the HM Substitution Algorithm was to identify the least hazardous, most technically-acceptable material by comparing two or more potential alternatives.

While performing the required risk analysis, AFMA completed HM Substitution Algorithm Worksheets to compare possible alternatives to those materials currently in use at IHD. These worksheets are provided in Appendix C. Each sheet contains the status quo alternative currently in use at IHD as Material A, with each of its pollution prevention alternatives as Material B. The points for each material were totaled at the bottom of each worksheet, and the material with the lowest score was the recommended product for that particular analysis. These scores proved to be both a comprehensive and a useful entry for comparison of one material with another.

4.6 The Market Availability Studies

In gathering the needed information for performing the economic and risk analyses from the manufacturers and distributors contacted by AFMA, the required market availability studies were completed. These studies involved first identifying feasible pollution prevention alternatives for the current methodologies observed on-site at IHD, and then conducting a market analysis as to their availability and associated costs. In addition to the manufacturers and distributors contacted, other sources of information included the GSA Spring 1996 Supply Catalog and the HMIS. These studies provided additional guidance for ranking the pollution prevention alternatives identified by AFMA. They involved researching less hazardous or non-hazardous materials to substitute those hazardous materials currently in use at IHD.

4.7 The Pollution Prevention (P2) System

The P2 System represented the integration of the HSMS, the NAVFAC P-442 Economic Analysis Model and the HM Substitution Process, and was essential for completion of the pollution prevention alternative assessments, as called for in the SOW. AFMA utilized this system to perform the required economic and risk analyses on the 79 pollution prevention alternatives developed for the 13 status quo alternatives observed on-site at IHD. The principal results of these analyses, along with supplementary information, are presented in Appendix D, List of Hazardous Material Substitutes Identified for IHD.

AFMA utilized the P2 System to store NSN, manufacturer and MSDS-related information for each of the pollution prevention alternatives developed by entering this information into the "System Information" Module. AFMA then transferred the baseline information entered into the HSMS for each of the status quo alternatives into the P2 System. AFMA utilized the "Run Analyses" Module to then perform the economic and risk analyses.

To perform the economic analysis through utilization of the NAVFAC P-442 Economic Analysis Model, Type II Net Present Value economic analysis format, AFMA first selected a status quo alternative and determined whether all appropriate information had been previously entered into the HSMS. This general material information included reporting requirements, safety and health information, physical properties and chemical constituent information. AFMA then entered into the P2 System the appropriate material annual costs, PPE costs and number of shop employees. AFMA selected a pollution prevention alternative, ensured that similar general information was stored within the P2 System for it, and then entered the appropriate material annual costs, PPE costs, number of shop employees. The system generated the resulting output report for each economic analysis performed, and AFMA provided recommendations as to the most cost-effective alternative, based upon the Net Present Value costs obtained. These steps were repeated a number of times to perform the economic analysis for other potential substitute materials against the same or different status quo alternative.

To perform the risk analysis through utilization of the HM Substitution Process, AFMA first selected a status quo alternative and determined whether the general material information had been previously entered into the HSMS. AFMA then entered into the P2 System the length of employee exposure into the system, identified that material's chemical constituent with the lowest listed Permissible Exposure Limit (PEL) or Threshold Limit Value (TLV), and acknowledged whether this constituent had any reporting requirements. AFMA selected a pollution prevention alternative, ensured that the general material information was stored within the P2 System for it, and followed the same steps. These steps were repeated a number of times to run the risk analysis on other potential substitute materials against the same or different status quo alternative.

4.8 Assumptions Made While Performing the Pollution Prevention Priority Number (PPPN) Analysis

A number of assumptions were made in order to perform the PPPN Analysis on the most promising pollution prevention alternatives identified for potential implementation at IHD. These assumptions ultimately affected the PPPNs for each of the materials analyzed and should be noted when considering the overall results. However, the analysis for each material was performed uniformly and therefore the results were consistently accurate. The assumptions AFMA made while performing the PPPN Analysis included the following:

a. A number of pollution prevention alternatives developed were comprised of two different materials, noted as Parts A and B, or Parts 1 and 2, and two HMSFs were computed for one material. Because the PPPN Analysis required only one HMSF, AFMA chose the higher of the two for incorporation into this analysis.
b. Similarly, two part materials yielded two ICFs. Because the PPPN Analysis required only one ICF, AFMA chose the higher of the two for incorporation into this analysis.

c. When calculating the ICF for some of the pollution prevention alternatives developed, AFMA calculated a negative change in HMSFs. Because there is no ICF value correlating to a negative change in HMSFs, AFMA assigned an ICF value of 40 to the pollution prevention alternatives in these instances. This was necessary for considering the worst case scenerio ICF for a situation in which there is $0.00 investment cost.

4.9 The Pollution Prevention Priority Number (PPPN) Analysis

AFMA utilized the PPPN Analysis to compare, and to determine the prioritization of, the most promising pollution prevention alternatives being considered for further analysis. The PPPN was computed by comparing several factors for each of the substitute materials proposed for implementation, as described below. In performing the PPPN Analysis, AFMA considered each potential alternative's environmental, safety and health benefits, as well its associated costs. It should be noted that, as a general rule, an alternative with a lower PPPN was prioritized over one with a higher PPPN. The methodology by which AFMA computed the PPPNs for the most promising pollution prevention alternatives, based upon the HMSFs previously calculated, is presented in Appendix E.

4.9.1 Hazardous Material Selection Factor (HMSF)

Using the P2 System, AFMA computed the HMSF for each status quo alternative and for each pollution prevention alternative. This value represented the final and most important indicator of each potential substitute's environmental, safety, and health benefits. The HMSF was utilized as a mechanism for ranking the pollution prevention alternatives developed, and was also incorporated into the calculations of the ICFs for the potential replacement materials.

4.9.2 Investment Cost Factor (ICF)

To successfully perform the PPPN Analysis, AFMA computed an ICF for each pollution prevention alternative. First, the difference between the pollution prevention alternative's and the status quo alternative's HMSFs was calculated. Then the pollution prevention alternative's initial cost (0 in all cases), was taken into consideration. Using these parameters, an ICF was assigned to each pollution prevention alternative, as shown in the following example:

Example: ACETONE

Step 1: Status Quo: Acetone
$HMSF^2$: 56

Step 2: Proposed: Nature-Sol 100
$HMSF^1$: 28

Step 3: $HMSF = HMSF^2 - HMSF^1$
$HMSF = 56 - 28 = \underline{28}$

Step 4: Initial cost of implementing the pollution prevention alternative = $0.00

Step 5: Using Appendix E, Figure E-1, Table A, the ICF is <u>20</u>

Appendix E, Figure E-2 displays the 13 status quo alternatives with the most promising pollution prevention alternatives and their ICF values.

4.9.3 Uniform Annual Cost Factor (UACF)

While utilizing the PPPN Analysis, AFMA computed a UACF for each pollution prevention alternative. This variable depended upon the percent change in the uniform annual costs (UAC) of each status quo alternative and each of its pollution prevention alternatives. It should be noted that a negative (positive) percent change in the UAC represents a percent change increase (decrease). Using this information, a UACF was assigned to each pollution prevention alternative, as shown in the following example:

Example: ACETONE

Step 1: Status Quo: Acetone
UAC^2: $586.45

Step 2: Proposed: Nature-Sol 100
UAC^1: $121.30

Step 3: Percentage change in the UAC = $[(UAC^2 - UAC^1) / UAC^2] * 100$
Percentage change in the UAC = [($586.45 - $121.30) / $586.45] * 100
Percentage change in the UAC = <u>79.32</u>

Step 4: Because the UAC decreases, Appendix E, Figure E-1, Table C, was used.
The UACF is <u>0.25</u>

Appendix E, Figure E-3 displays the 13 status quo alternatives with the most promising pollution prevention alternatives and their UACF values.

4.9.4 Weight Factor (WF)

AFMA computed the WF as the percent change in the weight of HMs anticipated as a result of implementing a recommended pollution prevention alternative. This value was used in conjunction with Tables B and C from Appendix E, Figure E-1. A negative (positive) percent change in the WF represented a percent change increase (decrease) for the factor being considered. For the purposes of the PPPN Analysis conducted for IHD, AFMA assigned a value of one to the WF, as the percent change in the weight of HMs anticipated as a result of implementing a recommended pollution prevention alternative will not change significantly.

4.9.5 Population Factor (PF)

AFMA calculated the PF as the percent change in the number of people exposed to HMs as a result of implementing their recommended pollution prevention alternative. This value was used in conjunction with Tables B and C from Appendix E, Figure E-1. A negative (positive) percent change in the PF represented a percent change increase (decrease) for the factor being considered. For the purposes of the PPPN Analysis conducted for IHD, AFMA assigned a value of one to the PF, as the percent change in the number of people exposed to HMs as a result of implementing recommended pollution prevention alternative will not change significantly.

4.10 The Benefit/Cost Ratio (BCR) Analysis

The BCR Analysis was the final tool by which AFMA analyzed the pollution prevention alternatives being considered for implementation at IHD. Based on the results of the PPPN Analysis, AFMA selected the most promising alternatives with the lowest PPPNs and performed a BCR Analysis on them. In doing so, AFMA identified all relevant inputs and outputs. These factors were then translated

into quantifiable costs and benefits. Costs were identified as the resources or inputs necessary to implement an alternative while benefits were regarded as the results or outputs resulting from implementation of the alternative. If a benefit was not quantifiable, it was qualified to support the analysis. As shown in this Technical Report, the results of a BCR Analysis did not always support the recommendation of a proposed alternative.

Because the recurring costs associated with the pollution prevention alternatives were quantifiable, AFMA computed a Direct Cost Savings - Benefit Analysis. This type of quantifiable benefit was represented by a reduced annual budget. A positive value represented a real cost savings. In this study, a real cost savings further supported the recommendation of a pollution prevention alternative for a status quo alternative. However, the three other types of benefits were not applicable to this analysis because the pollution prevention alternatives did not demonstrate Efficiency/Productivity Increases, Other Quantifiable Outputs or Non-Quantifiable Outputs.

Finally, AFMA accounted for the environmental merits associated with the pollution prevention alternatives. These non-quantifiable benefits are known as externalities, which are defined as outputs involuntarily received or imposed on a person or a group as a result of an action by another and over which the recipient has no control. As indicated by the NAVFAC P-442 Economic Analysis Model, externalities such as environmental impacts are usually addressed in detail as part of the environmental impact assessment/environmental impact statement process. Therefore, it is not necessary to analyze these benefits in the economic analysis. However, the Model does suggest that the economic analysis identify the qualitative advantages of implementing an alternative. This method of assessing the benefits contributed positively to the analysis. Even though this approach was non-economical, it did add value to the BCR Analysis and eased the decision-making process.

CHAPTER 5

TECHNICAL EVALUATION OF THE TOOLS USED TO CONDUCT THE FEASIBILITY ANALYSES AT INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER

5.0 SUMMARY OF FINDINGS

This chapter provides critical evaluation of each tool AFMA used to conduct the feasibility analyses, as called for in the SOW. A brief assessment of the HSMS, the NAVFAC P-442 Economic Analysis Model, the HM Substitution Process, the market availability studies, the P2 System, the PPPN Analysis and the BCR Analysis is provided in this chapter. In addition, the effectiveness of utilization of the P2 System for conducting pollution prevention alternative assessments, along with suggested changes and/or additions to the system, is included. Finally, this chapter provides an account of the problem areas AFMA encountered while using each tool to identify the optimum value pollution prevention alternatives for implementation at IHD.

5.1 The Hazardous Substance Management System (HSMS)

As previously discussed in the final Task 1 Technical Report, AFMA was charged with determining the feasibility of utilization of the HSMS for conducting pollution prevention alternative assessments. While simulating material transactions with the baseline information collected on-site at NDW, AFMA determined that the HSMS cannot be used alone as a tool for conducting pollution prevention alternative assessments at small, non-industrial type Naval facilities.

5.2 The NAVFAC P-442 Economic Analysis Model

Because AFMA did not obtain a substantial amount of cost data from representatives at IHD for incorporation into the NAVFAC P-442 Economic Analysis Model, a number of assumptions were made to successfully utilize the Type II Net Present Value economic analysis format (see Section 4.2). As a result, this analysis, as performed through utilization of the P2 System, provided a very basic comparison of the economic changes that would result from implementation of the proposed alternatives at IHD. However, the Model did allow AFMA to compute the status quo alternatives' and the pollution prevention alternatives' discount costs, which were used to identify those alternatives with low Net Present Value costs to be further analyzed.

5.3 The Hazardous Material (HM) Substitution Process

The HM Substitution Process proved to be an effective tool for conducting the feasibility analyses to identify optimum value pollution prevention alternatives. The Process, which AFMA employed through utilization of the P2 System, was a successful mechanism by which the status quo alternatives, and their pollution prevention alternatives, were evaluated. All necessary information was either collected on-site or obtained from sources such as MSDSs, the NIOSH Pocket Chemical Guide and EPA's Title III List of Lists. This information was entered into the P2 System's Substitute Analysis Module and the HMSFs were calculated. Due to the lack of information provided on the MSDSs, AFMA made a number of assumptions while utilizing this tool (see Section 4.4). Despite these assumptions, AFMA is confident that the HMSFs provided an accurate representation of the environmental, safety and health risks associated with each status quo alternative identified on-site and each pollution prevention alternative recommended for implementation at IHD.

5.4 The Market Availability Studies

AFMA performed the market availability studies in conjunction with the performance of the economic and risk analyses via the P2 System. These studies proved useful for identifying feasible pollution prevention alternatives for the hazardous material uses based on their availability and associated

costs. However, fundamental guidance necessary for performing the market availability studies is not currently available. As a result, it was only possible for AFMA to perform a first-order level of effort on costs. Thus, while AFMA determined that the market availability studies were effective in providing the additional guidance necessary to rank the pollution prevention alternatives, proper guidance must be developed in order to accurately perform these studies in the future.

5.5 The Pollution Prevention (P2) System

The P2 System was developed by Pacific Environmental Services, Inc. (PES) over the past six months in order to determine the feasibility of utilization of the HSMS, the NAVFAC P-442 Economic Analysis Model and the HM Substitution Process for conducting pollution prevention alternative assessments. This task was undertaken due to AFMA's findings in Task 1 that the HSMS cannot be used alone to conduct such assessments. AFMA utilized the P2 System to a considerable extent for conducting the feasibility analyses to identify the most promising pollution prevention alternatives for further analysis utilizing the PPPN Analysis and the BCR Analysis.

While utilizing the P2 System for conducting the pollution prevention alternative assessments, AFMA determined that the system generally provided accurate results and greatly assisted in reducing the list of 79 pollution prevention alternatives to the 32 which were further analyzed. The P2 System provided for the identification of the most cost-effective, environmentally-sound alternatives for recommended implementation at IHD. However, while utilizing the P2 System, AFMA identified minor changes, suggestions and additions that it recommends be made to the system before the program is introduced at Naval installations currently utilizing the HSMS (see Section 5.8).

5.6 The Pollution Prevention Priority Number (PPPN) Analysis

AFMA utilized the PPPN Analysis to further analyze the environmental, safety and health benefits associated with each of the most promising pollution prevention alternatives identified with the lowest HMSFs, as determined through utilization of the P2 System. This analysis provided a useful screening mechanism by which the most promising pollution prevention alternatives previously identified were analyzed in further detail in order to select the least hazardous materials on which to perform the BCR Analysis. The PPPN Analysis assisted with the prioritization of the 18 least hazardous and most economically feasible alternatives to undergo one final analysis before being recommended as optimum value pollution prevention alternatives for implementation at IHD.

Additionally, the PPPN Analysis assisted with assigning a numeric value to the most promising pollution prevention alternatives based on each material's HMSF, discount cost, and percentile changes in investment cost and uniform annual cost, population exposed and the weight of the material used. From the analyses conducted, AFMA computed each material's PPPN and gave highest priority for further analysis to those products with the lowest scores. A decrease in a material's HMSF, discount cost, and percentile changes in investment cost and uniform annual cost, population exposed and the weight of the material used, generally resulted in an increase in the priority with which a pollution prevention alternative was considered for further analysis. Thus, the PPPN Analysis was a straightforward mechanism by which the prioritization of those pollution prevention alternatives being considered for implementation at IHD was determined.

5.7 The Benefit/Cost Ratio (BCR) Analysis

The BCR Analysis provided an unbiased representation of the benefits versus cost implications of the most promising pollution prevention alternatives recommended for implementation at IHD. This analysis was the tool by which AFMA quantified all of the relevant inputs and outputs into costs and benefits for each of the most promising pollution prevention alternatives being considered for implementation at IHD. AFMA performed this analysis to facilitate the final evaluation of each pollution prevention alternative's associated costs and benefits to make a determination as to which pollution

prevention alternatives will provide the most results or outputs for the least resources or inputs to be expended upon implementation. While the quantification of benefits was a difficult process, AFMA did utilize the Direct Cost Benefits, which included a decrease in recurring annual costs based on a reduction in annual material costs and/or a reduction in PPE costs.

Finally, AFMA considered externalities while performing the BCR Analysis. While this type of benefit could not be quantified, the externalities did contribute positively to the BCR Analysis and were taken into consideration. When comparing two or more pollution prevention alternatives, a low HMSF was considered a benefit because it represented a more environmentally-preferable product. On the other hand, a high HMSF was considered a disbenefit because it represented a less environmentally-preferable product.

5.8 Recommended Changes and Additions to the Pollution Prevention (P2) System

The following lists those changes, suggestions and additions that AFMA recommends be made to the P2 System in order for it to be more accurately utilized in conducting pollution prevention alternative assessments:

a. In the "System Information" Module, the NSN Information menu option, AFMA encountered instances in which no NSN was available for a particular material; however, this field requires an entry in order for the information to be saved. *AFMA recommends that in the event that a NSN is not available, the P2 System allow the user to bypass this field by providing the option for "Not Known" to be selected. In this situation, the system should provide a link to the material in question to its item name, part number/trade name, and/or MSDS number.*

b. In the "System Information" Module, the NSN Information menu option, AFMA encountered instances in which duplicate NSNs were provided on the MSDSs for a number of different materials. The P2 System does not currently allow the user to enter the same NSN for more than one product. *AFMA recommends that the system be changed such that the user may duplicate NSN entries, and provide a link to the specific material by its item name, part number/trade name, and/or MSDS number.*

c. In the "System Information" Module, the MSDS Information menu option, the General tab, the user is asked to acknowledge whether or not a material is located on the installation's AUL. *AFMA recommends that the user have the option to select "Not Known" for AUL information, as IHD currently does not have one. Additionally, AFMA recommends that the user also have the option to select "Not Applicable," because any potential alternative being considered for implementation will not be on the installation's AUL.*

d. In the "System Information" Module, the MSDS Information menu option, the General tab, the user is asked to make a determination as to whether a material's specific chemical constituent, to be analyzed while performing the substitute analysis, is located on the Environmental Protection Agency (EPA)/ State/Local Regulations List, if it is a Resource Conservation and Recovery Act (RCRA) Waste not Otherwise Listed or if it requires a Federal or State Permit. However, at this time no field existing in which to identify the chemical constituent to be analyzed. *AFMA recommends that this General Tab include a field in which the user must first identify a chemical constituent to be analyzed, then allowing for identification of these regulatory or permitting requirements.*

e. In the "System Information" Module, the MSDS Information menu option, the General tab, the user must determine whether a material's chemical constituents require a Federal or State permit. *AFMA recommends that, if the user selects "Yes," a field appears which allows for*

entry of the permit number(s). AFMA recommends that the permit number(s) appear on the substitute analysis' resulting output report as well.

f. In the "System Information" Module, the MSDS Information menu option, the Medical tab, the system uploads health information from the Health Hazards - Acute and Chronic section of the MSDS data entry screen from within the HSMS. *AFMA recommends that instead, the P2 System upload the information entered into the Signs and Symptoms of Overexposure data entry screen from within the HSMS. Based on the analyses performed by AFMA, this data entry screen provides a more accurate representation of the medical effects associated with each material analyzed.*

g. In the "System Information" Module, the MSDS Information menu option, the Safety tab, the P2 System assigns a score of six points for respiratory and eye protection. There is no option to assign a point value for respiratory and skin protection. *AFMA recommends that the system allow the user to assign a score of six for such required protection.*

h. In the "System Information" Module, the MSDS Information menu option, the Chemicals tab, the system allows the user to assign a Permissible Exposure Limit (PEL) or Threshold Limit Value (TLV) to two decimal places only. AFMA encountered a situation where the chemical constituent being analyzed, Aliphatic Isocyanate, had a PEL of 0.005 ppm. This could only be represented within the system as 0.05. While this does not affect the HMSF and the overall results of the risk analysis, *AFMA recommends that the system be changed such that the system allows for the entry of a PEL or TLV of more than two decimal places, in order to provide representation of the chemical's true exposure restrictions.*

i. In the "Run Analyses" Module, the Substitute Analysis menu option, while performing the risk analysis, the user must first select a status quo alternative for comparison to pollution prevention alternatives. The information pertaining to the status quo alternatives is uploaded from the HSMS, and the corresponding point values for medical and safety effects must be entered into the P2 System, along with the material's physical properties (i.e., flash point, boiling point and vapor pressure). Once these values are entered into an abbreviated MSDS Information screen, the user performs the risk analysis. However, when the exposure restrictions of each chemical constituent are uploaded from the HSMS, the P2 System does not recognize the exposure values and units that were entered into the HSMS. *AFMA recommends that the abbreviated MSDS Information screen include a Chemicals tab, at which point the user may enter in the appropriate exposure values and units. As the P2 System is currently designed, the user must open up the MSDS Information menu option to enter this data and perform the risk analysis accurately.*

j. In the "Run Analyses" Module, the Substitute Analysis menu option, the Chemical Data tab, when a chemical constituent having no associated PEL or TLV is analyzed, the system interprets no entry into this field (in the "System Information" Module, MSDS Information menu option, Chemicals tab) as meaning that the exposure restriction for this particular chemical constituent is 0.00 parts per million (ppm). This results in the system assigning a numerical score, depending on the percentage of this chemical contained within the material, in the Exposure Restrictions field when performing the substitute analysis. However, if a chemical has no PEL or TLV, it should be assigned a score of 0. *AFMA recommends that the P2 System be changed such that a chemical constituent having no exposure restrictions be assigned a point value of 0 in this field within the Substitution Algorithm. As the system is currently designed, such materials receive higher scores than they should, thereby resulting in a higher, and inaccurate HMSF.*

k. In the "Run Analyses" Module, the Substitute Analysis menu option, the Process tab currently allows the user to link a specific risk analysis with a specific process. This is performed by

allowing the user to select the appropriate work center, process code and identification number, process description and quantity of material used per year. *AFMA recommends that in addition to this information, the appropriate building number and building description be included in this process information. AFMA also recommends that the associated building number and/or process description be displayed as a footer on the resulting output report, as this information does not currently appear on the Substitution Algorithm Worksheets. In addition to the Similar Operational Use currently displayed on the output report, the inclusion of this additional information would provide more specific details about which process the analysis is performed for.*

l. In the "Run Analyses" Module, the Substitute Analysis menu option, *AFMA recommends that the P2 System allow the user to insert comments into the HM Substitution Algorithm Worksheets.*

m. In the "Run Analyses" Module, the Type I and Type II Economic Analysis menu options, the P2 System allows the user to enter material annual costs and PPE costs into the data entry fields in order to perform the economic analysis. However, in using the system, AFMA has determined that additional fields must be incorporated into the General and PPE Costs tabs, such as transportation/shipping costs, disposal costs and training costs, in order to provide a more detailed account of all costs affecting a process change or a material substitute. As the P2 System is currently, AFMA had to include shipping costs in the material annual costs while performing the required analyses. *AFMA recommends that additional fields be incorporated into the system detailing this specific information, and that the system include a user option to view this information on the computer screen or in the resulting output report, if desired.*

CHAPTER 6

RECOMMENDATIONS AND CONCLUSIONS

6.0 SUMMARY OF FINDINGS

This chapter outlines the combined results of the economic and risk analyses, performed via the P2 System, the market availability studies, the PPPN Analysis and the BCR Analysis, as utilized by AFMA to conduct the required feasibility analyses. Figure 1 displays the optimum value pollution prevention alternatives that AFMA recommends for implementation at IHD, based upon the results of these analyses.

	Product	Bldg.	Alternative	HMSF	UAC ($)	Initial Cost ($)	PPPN	Direct Cost Benefit ($)
	SS-4004 Silicone Primer	292	Status Quo	18	634.00	[1]	[1]	[1]
1	NONE		Proposed		-	-	-	-
	MS-143 Fluorocarbon Relesae Agent	292	Status Quo	46	612.80	0.00	-	-
2	Release #1 VOC		Proposed	23	87.62	0.00	2.0	525.18
	A-12 Parts A and B Adhesive	720	Status Quo	15/15	1,904.50	0.00	-	-
3	PSI-367 Parts A & B Epoxy Paste		Proposed	14	317.90	0.00	3.0	1,586.60
	Acetone	720, 160	Status Quo	56	586.45	0.00	-	-
4	Safety Prep, FD 080		Proposed	17	579.95	0.00	9.5	6.50
	Acetone	1040, 715	Status Quo	56	4,904.80	0.00	-	-
4	Safety Prep, FD 080		Proposed	17	5,069.80	0.00	10.5	(165.00)
	Toluene (Cleaning of Mix Bowl/Cast Tooling)	1190, 1041	Status Quo	71	3,318.08	0.00	-	-
5	Klean-Strip Mil-Klean		Proposed	28	8,013.40	0.00	20.0	(4,695.32)
	Toluene (Daily Cleanup of Mix Blades)	1190	Status Quo	71	82.66	0.00	-	-
6	Hurrisafe 9040 Special Formula		Proposed	15	152.72	0.00	20.0	(70.06)
	#1001 Zinc Primer Liquid	715	Status Quo	48	2,846.20	0.00	-	-
7	TT-E-545C Alkyd Primer		Proposed	18	2,344.60	0.00	13.0	501.60
	MIL-T-81772B Solvent Thinner	715	Status Quo	50	6,652.60	0.00	-	-
8	TT-T-291E Thinner		Proposed	23	557.80	0.00	2.0	6,094.80
	CHEMGLAZE 9951 Thinner	715	Status Quo	45	2,585.84	0.00	-	-
8	TT-T-291E Thinner		Proposed	23	557.80	0.00	2.0	2,028.04
	Thinner Synthetic Resin Enamel	715	Status Quo	41	765.40	0.00	-	-
8	TT-T-291E Thinner		Proposed	23	557.80	0.00	21.0	207.60
	Mineral Spirits	715	Status Quo	45	476.44	0.00	-	-
8	TT-T-291E Thinner		Proposed	23	557.80	0.00	24.0	(81.36)
	More than one[2]	715	Status Quo	[2]	-	-	-	-
9	Heat Resisting EN-TT-E-496A 14391		Proposed	29	3,694.60	[3]	[3]	[3]
10	A-58A Enamel (TT-E-516A)		Proposed	27	2,340.80	[3]	[3]	[3]
11	TT-E-489H Low VOC (15182 Blue)		Proposed	31	2,931.64	[3]	[3]	[3]

( ) denotes a negative value

1 - Status Quo recommended over pollution prevention alternatives based on environmental impacts

2 - More than one Status Quo sharing common Pollution Prevention Alternatives

3 - Varies depending on status quo, but each is significantly more cost effective and environmentally sound than the Status Quo

Figure 1
The Eleven Most Promising Pollution
Prevention Alternatives Recommended for Implementation at IHD

6.1 Findings and Recommendations

AFMA identified 79 pollution prevention alternatives for the 13 status quo hazardous material uses identified on-site at IHD. These alternatives were critically evaluated and the most promising ones were identified based on the results of the feasibility analyses conducted, primarily through utilization of the P2 System. While performing the economic and risk analyses, AFMA assumed that HMSFs took priority over costs in all comparisons. Materials with relatively high costs and relatively low HMSFs were carefully considered against materials with low to moderate costs and moderate to high HMSFs. That is, materials were not blindly selected for their low HMSFs. AFMA then applied the PPPN Analysis to further analyze the 32 pollution prevention alternatives having the lowest HMSFs for their environmental,

safety and health benefits, in order to identify the optimum value pollution prevention alternatives (see Table 2). Finally, AFMA utilized the BCR Analysis as a final mechanism for determining which of the 18 pollution prevention alternatives with the lowest PPPNs will offer the most results or outputs for the least resources or inputs (see Table 3). The following paragraphs briefly describe the pollution prevention alternatives developed by AFMA.

6.1.1 Silicone Primer

Building 292 uses SS-4004 Silicone Primer, manufactured by the General Electric Company, for Mold Assembly, MK-128 JATO - Cleaning and Treating Endformers. AFMA conducted the feasibility analyses on four alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 18 (SS-4004 Silicone Primer) to 51 (1204 Adhesive Primer). The discounted costs range from $275.33 (All Purpose Silicone Primer) to $5965.49 (Norsil Silicone Primer). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 4 (All Purpose Primer) to 42 (1200 RTV Primer). Based on this, AFMA utilized the BCR Analysis to further analyze the All Purpose Primer, manufactured by Seymour of Sycamore, Inc., and 1200 RTV Primer, manufactured by Dow Corning Corp.

6.1.2 Release Agent

Building 292 uses MS-143 Fluorocarbon Release Agent, manufactured by Miller-Stephenson Chemical Company, for Mold Assembly, MK-128 JATO - Application of Release Agent to Warheads. AFMA conducted the feasibility analyses on eight alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 20 (Spectrum Release W.B.) to 57 (1-2531 Release Coating). The discounted costs range from $615.41 (Release #1 VOC) to $4304.06 (MS-143 Fluorocarbon Release Agent). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 2 (Release #1 VOC) to 12 (Release All Safelease 30). Based on this, AFMA utilized the BCR Analysis to further analyze the Release #1 VOC and the Spectrum Release W.B., both manufactured by Edoco.

6.1.3 Adhesives

Building 720 uses A-12 Parts A and B Adhesive, manufactured by Armstrong Products Company, for Inspection/Rework of Rocket Motors. AFMA conducted the feasibility analyses on 13 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 14 (A-1177-B-1 Two Part Epoxy Adhesive (Part A); PSI-367 Parts A and B Epoxy Paste) to 69 (L-6261 GSA Adhesive). The discounted costs range from $480.13 (MMM-A-1058A Adhesive, PC-NAPCO) to $8181.79 (PSI-322 Clear & FD Clear Epoxy Gel, Parts A and B). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 3 (A-1177-B Epoxy Adhesive, Parts A and B; PSI-367 Epoxy Paste, Parts A and B) to 18 (PSI-322 Clear & FD Clear Epoxy Gel, Parts A and B). Based on this, AFMA utilized the BCR Analysis to further analyze the A-1177-B Epoxy Adhesive, Parts A and B, manufactured by B.F. Goodrich, and the PSI-367 Epoxy Paste, Parts A and B, manufactured by Polymeric Systems, Inc.

6.1.4 Acetone

Buildings 160 and 720 use approximately the same yearly quantity of Acetone, manufactured by Mallinckrodt Chemical, Inc., for CAD Remanufacture and Inspection/Rework of Rocket Motors, respectively. AFMA conducted the feasibility analyses on six alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 17 (Safety Prep, FD 080) to 56 (Acetone). The discounted costs range from $851.96 (Nature-Sol 100) to $10333.82 (Brulin SD 1291). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 5 (Nature-Sol 100) to 40 (Finger

Table 2. List of Most Promising Pollution Prevention Alternatives Identified for Indian Head Division, Naval Surface Warfare Center

	Hazardous Material	Bldg.	Alternative	Product	Manufacturer	Discounted Cost	HMSF
1	Silicone Primer	292	Status Quo	**SS-4004 Silicone Primer**	**General Electric Company**	$ 4,452.96	18
			Proposed	1200 RTV Primer	Dow Corning Corp.	$ 5,304.21	37
			Proposed	All Purpose Primer	Seymour of Sycamore, Inc.	$ 275.33	36
2	Release Agent	292	Status Quo	**MS-143 Fluorocarbon Release Agent**	**Miller-Stephenson Chemical**	$ 4,304.06	46
			Proposed	MS-143N Release Agent/Dry Lubricant	Miller-Stephenson Chemical	$ 1,430.00	37
			Proposed	MS-122N/CO2 TFE Release Agent	Miller-Stephenson Chemical	$ 942.57	37
			Proposed	Spectrum Release W.B.	Edoco	$ 1,508.95	20
			Proposed	Release #1 VOC	Edoco	$ 615.41	23
			Proposed	Release All Safelease 30	Airtech International Inc.	$ 2,702.26	21
3	Adhesives	720	Status Quo	**A-12 Parts A and B Adhesive**	**Armstrong Products Co.**	$ 7,687.33	15/15
			Proposed	A-1177-B-1 Epoxy Adhesive Parts A and B	B.F. Goodrich	$ 2,864.22	14/17
			Proposed	PSI-322 Clear & FD Clear Epoxy Gel Parts A & B	Polymeric Systems, Inc.	$ 8,181.79	18/20
			Proposed	PSI-367 Parts A and B Epoxy Paste	Polymeric Systems, Inc.	$ 2,232.80	14/14
4	Acetone	720, 160	Status Quo	**Acetone**	**Mallinckrodt Chemical, Inc.**	$ 4,118.99	56
			Proposed	Finger Lakes ID/4R, P/N-FLSC-98	Finger Lakes Chemical	$ 6,365.14	23
			Proposed	3-D Degreaser, P/N-FLSC-97	Finger Lakes Chemical	$ 5,446.45	19
			Proposed	Nature-Sol 100	Brulin and Company, Inc.	$ 851.96	28
			Proposed	Safety Prep, FD 080	Inland Technology, Inc.	$ 4,073.34	17
4	Acetone	1040, 715	Status Quo	**Acetone**	**Mallinckrodt Chemical, Inc.**	$ 34,449.35	56
			Proposed	Finger Lakes ID/4R, P/N-FLSC-98	Finger Lakes Chemical	$ 56,856.04	23
			Proposed	3-D Degreaser, P/N-FLSC-97	Finger Lakes Chemical	$ 48,449.14	19
			Proposed	Nature-Sol 100	Brulin and Company, Inc.	$ 5,418.71	28
			Proposed	Safety Prep, FD 080	Inland Technology, Inc.	$ 35,608.25	17
5	Toluene	1190, 1041	Status Quo	**Toluene (Cleaning of Mix Bowl/Cast Tooling)**	**Ashland Chemical**	$ 23,304.87	71
			Proposed	Klean-Strip Mil-Klean	W.M. Barr & Company, Inc.	$ 56,282.92	28
			Proposed	Hurrisafe 9040 Special Formula	PCI of America	$ 132,738.45	15
			Proposed	Safety Prep, FD 080	Inland Technology, Inc.	$ 105,141.89	17
5	Toluene	1190	Status Quo	**Toluene (Daily Cleanup of Mix Blades)**	**Ashland Chemical**	$ 580.57	71
			Proposed	Hurrisafe 9040 Special Formula	PCI of America	$ 1,072.64	15
			Proposed	FC056 Citra Safe	Inland Technology, Inc.	$ 3,512.15	24
			Proposed	Safety Prep, FD 080	Inland Technology, Inc.	$ 1,053.19	17

[1] Discounted Cost = Annual Cost * Dicount Factor
[2] HMSF = Hazardous Material Selection Factor

Table 2. List of Most Promising Pollution Prevention Alternatives Identified for Indian Head Division, Naval Surface Warfare Center

	Hazardous Material	Bldg.	Alternative	Product	Manufacturer	Discounted Cost	HMSF
6	**Primer**	715	Status Quo	**#1001 Zinc Primer Liquid**	**PPG Industries, Inc.**	$ 19,990.57	48
			Proposed	TT-E-545C Alkyd Primer	Davlin Paint Company, Inc.	$ 12,853.19	18
			Proposed	Primer Coating, Zinc Chromate Comp L	Pratt and Lambert	$ 18,903.32	34
			Proposed	TT-P-1757 Zinc Chromate Primer (Yellow)	Kop-Coat Inc.	$ 16,467.53	35
			Proposed	Lacquer Primer MIL-P-7962	Randolph Products Company	$ 26,067.39	31
7	**Paint Thinner**	715	Status Quo	**MIL-T-81772B Solvent Thinner**	**DeSoto, Inc.**	$ 46,725.20	50
			Proposed	TT-T-291E Thinner	Atlas Paint and Varnish Company	$ 3,917.76	23
			Proposed	TL 102 Thinner, Aliphatic, Polyurethane	Sikkens Aerospace Finishes Div.	$ 5,827.62	39
			Proposed	Chevron Thinner 350 H	Chevron Environmental Health Cntr	$ 3,715.48	40
			Proposed	Klean-Strip Mineral Spirits, PN-GMS44	W.M. Barr and Company, Inc.	$ 5,131.44	41
7	**Paint Thinner**	715	Status Quo	**CHEMGLAZE 9951 Thinner**	**Lord Corp Chemical Products**	$ 18,161.91	45
			Proposed	TT-T-291E Thinner	Atlas Paint and Varnish Company	$ 3,917.76	23
			Proposed	TL 102 Thinner, Aliphatic, Polyurethane	Sikkens Aerospace Finishes Div.	$ 5,827.62	39
			Proposed	Chevron Thinner 350 H	Chevron Environmental Health Cntr	$ 3,715.48	40
			Proposed	Klean-Strip Mineral Spirits, PN-GMS44	W.M. Barr and Company, Inc.	$ 5,131.44	41
7	**Paint Thinner**	715	Status Quo	**Thinner Synthetic Resin Enamel**	**CSD, Inc.**	$ 5,375.86	41
			Proposed	TT-T-291E Thinner	Atlas Paint and Varnish Company	$ 3,917.76	23
			Proposed	TL 102 Thinner, Aliphatic, Polyurethane	Sikkens Aerospace Finishes Div.	$ 5,827.62	39
			Proposed	Chevron Thinner 350 H	Chevron Environmental Health Cntr	$ 3,715.48	40
7	**Paint Thinner**	715	Status Quo	**Mineral Spirits**	**CSD, Inc.**	$ 3,346.32	45
			Proposed	TT-T-291E Thinner	Atlas Paint and Varnish Company	$ 3,917.76	23
			Proposed	TL 102 Thinner, Aliphatic, Polyurethane	Sikkens Aerospace Finishes Div.	$ 5,827.62	39
			Proposed	Chevron Thinner 350 H	Chevron Environmental Health Cntr	$ 3,715.48	40
			Proposed	Klean-Strip Mineral Spirits, PN-GMS44	W.M. Barr and Company, Inc.	$ 5,131.44	41
8	**Paint**	715	Status Quo	**Krylon High Heat Spray Paint**	**Division of Borden**	$ 25,966.25	38
			Proposed	Heat Resisting EN-TT-E-496A 14391	Warren Paint & Color Company	$ 25,949.39	29
			Proposed	A-58A Enamel (TT-E-516A)	Koppers Company	$ 16,440.84	27
			Proposed	TT-E-489H Low VOC (15182 Blue)	Kop-Coat Inc.	$ 20,590.67	31
			Proposed	Polyurethane Coating, Black 17038, Parts 1 & 2	Dexter Coatings	$ 34,153.80	36/52
8	**Paint**	715	Status Quo	**Krylon 1402 High Heat Alum Paint**	**Division of Borden**	$ 25,966.25	35
			Proposed	Polyurethane Coating, Green 24052, Parts 1 and 2	Deft, Inc.	$ 34,047.60	35/44
			Proposed	Heat Resisting EN-TT-E-496A 14391	Warren Paint & Color Company	$ 25,949.39	29
			Proposed	A-58A Enamel (TT-E-516A)	Koppers Company	$ 16,440.84	27
			Proposed	TT-E-489H Low VOC (15182 Blue)	Kop-Coat Inc.	$ 20,590.67	31

[1] Discounted Cost = Annual Cost * Dicount Factor
[2] HMSF = Hazardous Material Selection Factor

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	Hazardous Material	Bldg.	Alternative	Product	Manufacturer	Discounted Cost	HMSF
8	Paint	715	Status Quo	**Epoxy, MIL-P-85582B, TY 1 Cl C1**	**Deft, Inc.**	$ 57,184.75	34
			Proposed	Polyurethane Coating, Green 24052, Parts 1 and 2	Deft, Inc.	$ 34,047.60	35/44
			Proposed	Heat Resisting EN-TT-E-496A 14391	Warren Paint & Color Company	$ 25,949.39	29
			Proposed	A-58A Enamel (TT-E-516A)	Koppers Company	$ 16,440.84	27
			Proposed	TT-E-489H Low VOC (15182 Blue)	Kop-Coat Inc.	$ 20,590.67	31
8	Paint	715	Status Quo	**Aliphatic Isocyanate**	**Deft, Inc.**	$ 48,983.59	46
			Proposed	Polyurethane Coating, Green 24052, Parts 1 and 2	Deft, Inc.	$ 34,047.60	35/44
			Proposed	Polyurethane Coating, Black 37038, Parts 1 and 2	Deft, Inc.	$ 33,154.20	40/36
			Proposed	Heat Resisting EN-TT-E-496A 14391	Warren Paint & Color Company	$ 25,949.39	29
			Proposed	A-58A Enamel (TT-E-516A)	Koppers Company	$ 16,440.84	27
			Proposed	TT-E-489H Low VOC (15182 Blue)	Kop-Coat Inc.	$ 20,590.67	31
			Proposed	Polyurethane Coating, Black 17038, Parts 1 and 2	Dexter Coatings	$ 34,153.80	36/52
8	Paint	715	Status Quo	**Polyurethane, MIL-C-85285B, 17925 TY I**	**Deft, Inc.**	$ 27,432.78	34
			Proposed	Polyurethane Coating, Green 24052, Parts 1 and 2	Deft, Inc.	$ 34,047.60	35/44
			Proposed	Heat Resisting EN-TT-E-496A 14391	Warren Paint & Color Company	$ 25,949.39	29
			Proposed	A-58A Enamel (TT-E-516A)	Koppers Company	$ 16,440.84	27
			Proposed	TT-E-489H Low VOC (15182 Blue)	Kop-Coat Inc.	$ 20,590.67	31
8	Paint	715	Status Quo	**Pigmented Polymer**	**Chemray Coatings Corp**	$ 18,706.09	41
			Proposed	Polyurethane Coating, Green 24052, Parts 1 and 2	Deft, Inc.	$ 34,047.60	35/44
			Proposed	Polyurethane Coating, Black 37038, Parts 1 and 2	Deft, Inc.	$ 33,154.20	40/36
			Proposed	Heat Resisting EN-TT-E-496A 14391	Warren Paint & Color Company	$ 25,949.39	29
			Proposed	A-58A Enamel (TT-E-516A)	Koppers Company	$ 16,440.84	27
			Proposed	TT-E-489H Low VOC (15182 Blue)	Kop-Coat Inc.	$ 20,590.67	31
8	Paint	715	Status Quo	**So-Sure Lacquer**	**LHB Industries**	$ 14,368.88	58
			Proposed	Polyurethane Coating, Green 24052, Parts 1 and 2	Deft, Inc.	$ 34,047.60	35/44
			Proposed	Polyurethane Coating, Black 37038, Parts 1 and 2	Deft, Inc.	$ 33,154.20	40/36
			Proposed	Polyurethane High Solids, Black 37038, Pts 1&2	Dexter Coatings	$ 31,625.87	38/60
			Proposed	Heat Resisting EN-TT-E-496A 14391	Warren Paint & Color Company	$ 25,949.39	29
			Proposed	A-58A Enamel (TT-E-516A)	Koppers Company	$ 16,440.84	27
			Proposed	TT-E-489H Low VOC (15182 Blue)	Kop-Coat Inc.	$ 20,590.67	31
			Proposed	Polyurethane Coating, Black 17038, Parts 1 and 2	Dexter Coatings	$ 34,153.80	36/52

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[2] HMSF = Hazardous Material Selection Factor

Table 2. List of Most Promising Pollution Prevention Alternatives Identified for Indian Head Division, Naval Surface Warfare Center

	Hazardous Material	Bldg.	Alternative	Product	Manufacturer	Discounted Cost	HMSF
8	**Paint**	715	Status Quo	**So-Sure Blue 35109 (54-350)P**	**LHB Industries**	$ 14,908.29	51
			Proposed	Polyurethane Coating, Green 24052, Parts 1 and 2	Deft, Inc.	$ 34,047.60	35/44
			Proposed	Polyurethane Coating, Black 37038, Parts 1 and 2	Deft, Inc.	$ 33,154.20	40/36
			Proposed	Polyurethane High Solids, Black 37038, Pts 1&2	Dexter Coatings	$ 31,625.87	38/60
			Proposed	Heat Resisting EN-TT-E-496A 14391	Warren Paint & Color Company	$ 25,949.39	29
			Proposed	A-58A Enamel (TT-E-516A)	Koppers Company	$ 16,440.84	27
			Proposed	TT-E-489H Low VOC (15182 Blue)	Kop-Coat Inc.	$ 20,590.67	31
			Proposed	Polyurethane Coating, Black 17038, Parts 1 and 2	Dexter Coatings	$ 34,153.80	36/52
8	**Paint**	715	Status Quo	**So-Sure Yellow 23538 (114-230)G**	**LHB Industries**	$ 16,391.68	67
			Proposed	Polyurethane Coating, Green 24052, Parts 1 and 2	Deft, Inc.	$ 34,047.60	35/44
			Proposed	Polyurethane Coating, Black 37038, Parts 1 and 2	Deft, Inc.	$ 33,154.20	40/36
			Proposed	Heat Resisting EN-TT-E-496A 14391	Warren Paint & Color Company	$ 25,949.39	29
			Proposed	A-58A Enamel (TT-E-516A)	Koppers Company	$ 16,440.84	27
			Proposed	TT-E-489H Low VOC (15182 Blue)	Kop-Coat Inc.	$ 20,590.67	31
			Proposed	Polyurethane Coating, Black 17038, Parts 1 and 2	Dexter Coatings	$ 34,153.80	36/52
8	**Paint**	715	Status Quo	**Metallic Topcoats**	**Rust-Oleum Corporation**	N/A	N/A
				Discontinued			
8	**Paint**	715	Status Quo	**HARD HAT Fluorescent Topcoats**	**Rust-Oleum Corporation**	$ 54,018.51	75
			Proposed	Polyurethane Coating, Green 24052, Parts 1 and 2	Deft, Inc.	$ 34,047.60	35/44
			Proposed	Polyurethane High Solids, Black 37038, Pts 1&2	Dexter Coatings	$ 33,154.20	38/60
			Proposed	Heat Resisting EN-TT-E-496A 14391	Warren Paint & Color Company	$ 25,949.39	29
			Proposed	A-58A Enamel (TT-E-516A)	Koppers Company	$ 16,440.84	27
			Proposed	TT-E-489H Low VOC (15182 Blue)	Kop-Coat Inc.	$ 20,590.67	31
8	**Paint**	715	Status Quo	**PC-118 Polyurethane Curing Solution**	**Crown Metro Aerospace**	$ 47,922.02	52
			Proposed	Polyurethane Coating, Green 24052, Parts 1 and 2	Deft, Inc.	$ 34,047.60	35/44
			Proposed	Heat Resisting EN-TT-E-496A 14391	Warren Paint & Color Company	$ 25,949.39	29
			Proposed	A-58A Enamel (TT-E-516A)	Koppers Company	$ 16,440.84	27
			Proposed	TT-E-489H Low VOC (15182 Blue)	Kop-Coat Inc.	$ 20,590.67	31
			Proposed	Polyurethane Coating, Black 17038, Parts 1 and 2	Dexter Coatings	$ 34,153.80	36/52
8	**Paint**	715	Status Quo	**Aliphatic Polyurethane & Coreactant**	**Randolph Products Co.**	N/A	N/A
				Discontinued			
8	**Paint**	715	Status Quo	**TY 1 #20117 Brown Air Dry Enamel**	**Randolph Products Co.**	$ 47,872.86	41
			Proposed	Polyurethane Coating, Green 24052, Parts 1 and 2	Deft, Inc.	$ 34,047.60	35/44
			Proposed	Heat Resisting EN-TT-E-496A 14391	Warren Paint & Color Company	$ 25,949.39	29
			Proposed	A-58A Enamel (TT-E-516A)	Koppers Company	$ 16,440.84	27
			Proposed	TT-E-489H Low VOC (15182 Blue)	Kop-Coat Inc.	$ 20,590.67	31
			Proposed	Polyurethane Coating, Black 17038, Parts 1 and 2	Dexter Coatings	$ 34,153.80	36/52

[1] Discounted Cost = Annual Cost * Dicount Factor
[2] HMSF = Hazardous Material Selection Factor

Table 2. List of Most Promising Pollution Prevention Alternatives Identified for Indian Head Division, Naval Surface Warfare Center

	Hazardous Material	Bldg.	Alternative	Product	Manufacturer	Discounted Cost	HMSF
8	**Paint**	715	Status Quo	**Epoxy Catalyst**	**Randolph Products Co.**	$ 58,408.26	43
			Proposed	Polyurethane Coating, Green 24052, Parts 1 and 2	Deft, Inc.	$ 34,047.60	35/44
			Proposed	Heat Resisting EN-TT-E-496A 14391	Warren Paint & Color Company	$ 25,949.39	29
			Proposed	A-58A Enamel (TT-E-516A)	Koppers Company	$ 16,440.84	27
			Proposed	TT-E-489H Low VOC (15182 Blue)	Kop-Coat Inc.	$ 20,590.67	31
			Proposed	Polyurethane Coating, Black 17038, Parts 1 and 2	Dexter Coatings	$ 34,153.80	36/52
8	**Paint**	715	Status Quo	**Catalyst Aliphatic Isocyanate Reactant**	**Randolph Products Co.**	$ 67,672.39	53
			Proposed	Polyurethane Coating, Green 24052, Parts 1 and 2	Deft, Inc.	$ 34,047.60	35/44
			Proposed	Polyurethane Coating, Black 37038, Parts 1 and 2	Deft, Inc.	$ 33,154.20	40/36
			Proposed	Heat Resisting EN-TT-E-496A 14391	Warren Paint & Color Company	$ 25,949.39	29
			Proposed	A-58A Enamel (TT-E-516A)	Koppers Company	$ 16,440.84	27
			Proposed	TT-E-489H Low VOC (15182 Blue)	Kop-Coat Inc.	$ 20,590.67	31
			Proposed	Polyurethane Coating, Black 17038, Parts 1 and 2	Dexter Coatings	$ 34,153.80	36/52
8	**Paint**	715	Status Quo	**KEM TRANSPORT Synthetic Enamel**	**The Sherwin Williams Co.**	N/A	N/A
				Custom-Made Product			

[1] Discounted Cost = Annual Cost * Dicount Factor
[2] HMSF = Hazardous Material Selection Factor

Table 3. The Benefit/Cost Ratio Analysis

Product	BLDG.	Alternative	HMSF	UAC ($)	Initial Cost ($)	PPPN	Direct Cost Benefit ($)
SS-4004 Silicone Primer	**292**	Status Quo	18	634.00	0.00	-	-
All Purpose Primer		Proposed	36	39.20	0.00	4.0	594.80
1200 RTV Primer		Proposed	37	646.09	0.00	42.0	(12.09)
MS-143 Fluorocarbon Release Agent ~	**292**	Status Quo	46	612.80	0.00	-	-
Release #1 VOC		Proposed	23	87.62	0.00	2.0	525.18
Spectrum Release W.B.		Proposed	20	214.84	0.00	5.0	397.96
A-12 Parts A and B Adhesive	**720**	Status Quo	15/15	1,904.50	0.00	-	-
A-1177-B-1 Epoxy Adhesive Parts A & B		Proposed	17	407.80	0.00	3.0	1,496.70
PSI-367 Parts A & B Epoxy Paste		Proposed	14	317.90	0.00	3.0	1,586.60
Acetone ~	**720, 160**	Status Quo	56	586.45	0.00	-	-
Nature-Sol 100		Proposed	28	121.30	0.00	5.0	465.15
Safety Prep, FD 080		Proposed	17	579.95	0.00	9.5	6.50
Acetone ~	**1040, 715**	Status Quo	56	4,904.80	0.00	-	-
Nature-Sol 100		Proposed	28	771.50	0.00	2.0	4,133.30
Safety Prep, FD 080		Proposed	17	5,069.80	0.00	10.5	(165.00)
Toluene (Cleaning of Mix Bowl/Cast Tooling) ~	**1190, 1041**	Status Quo	71	3,318.08	0.00	-	-
Klean-Strip Mil-Klean		Proposed	28	8,013.40	0.00	20.0	(4,695.32)
Hurrisafe 9040 Special Formula		Proposed	15	18,898.92	0.00	20.0	(15,580.84)
Safety Prep, FD 080		Proposed	17	14,969.80	0.00	20.0	(11,651.72)
Toluene (Daily Cleanup of Mix Blades) ~	**1190**	Status Quo	71	82.66	0.00	-	-
Hurrisafe 9040 Special Formula		Proposed	15	152.72	0.00	20.0	(70.06)
FC056 Citra Safe		Proposed	24	500.05	0.00	20.0	(417.39)
Safety Prep, FD 080		Proposed	17	149.95	0.00	20.0	(67.29)
#1001 Zinc Primer Liquid ~	**715**	Status Quo	48	2,846.20	0.00	-	-
TT-E-545C Alkyd Primer		Proposed	18	2,344.60	0.00	13.0	501.60
MIL-T-81772B Solvent Thinner ~	**715**	Status Quo	50	6,652.60	0.00	-	-
TT-T-291E Thinner		Proposed	23	557.80	0.00	2.0	6,094.80
CHEMGLAZE 9951 Thinner ~	**715**	Status Quo	45	2,585.84	0.00	-	-
TT-T-291E Thinner		Proposed	23	557.80	0.00	2.0	2,028.04
Chevron Thinner 350 H		Proposed	40	529.00	0.00	3.0	2,056.84
Thinner Synthetic Resin Enamel ~	**715**	Status Quo	41	765.40	0.00	-	-
TT-T-291E Thinner		Proposed	23	557.80	0.00	21.0	207.60
Chevron Thinner 350 H		Proposed	40	529.00	0.00	21.0	236.40
Mineral Spirits	**715**	Status Quo	45	476.44	0.00	-	-
TT-T-291E Thinner		Proposed	23	557.80	0.00	24.0	(81.36)
Krylon High Heat Spray Paint ~	**715**	Status Quo	38	3,697.00	0.00	-	-
A-58A Enamel (TT-E-516A)		Proposed	27	2,340.80	0.00	18.0	1,356.20
TT-E-489H Low VOC (15182 Blue)		Proposed	31	2,931.64	0.00	22.5	765.36
Krylon 1402 High Heat Alum Paint ~	**715**	Status Quo	35	3,687.00	0.00	-	-
A-58A Enamel (TT-E-516A)		Proposed	27	2,340.80	0.00	18.0	1,346.20
TT-E-489H Low VOC (15182 Blue)		Proposed	31	2,931.64	0.00	24.0	755.36
Epoxy, MIL-P-85582B, TY 1 Cl C1	**715**	Status Quo	34	8,141.80	0.00	-	-
Heat Resisting EN-TT-E-496A 14391		Proposed	29	3,694.60	0.00	7.5	4,447.20
A-58A Enamel (TT-E-516A)		Proposed	27	2,340.80	0.00	7.5	5,801.00
TT-E-489H Low VOC (15182 Blue)		Proposed	31	2,931.64	0.00	7.5	5,210.16

( ) denotes a negative value
HMSF=Hazardous Material Selection Factor
UAC=Uniform Annual Cost
PPPN=Pollution Prevention Priority Number
~ =not a potential alternative

Table 3. The Benefit/Cost Ratio Analysis

Product	BLDG.	Alternative	HMSF	UAC ($)	Initial Cost ($)	PPPN	Direct Cost Benefit ($)
Aliphatic Isocyanate ~	715	Status Quo	46	7,116.52	0.00	-	-
A-58A Enamel (TT-E-516A)		Proposed	27	2,340.80	0.00	7.5	4,775.72
TT-E-489H Low VOC (15182 Blue)		Proposed	31	2,931.64	0.00	7.5	4,184.88
Heat Resisting EN-TT-E-496A 14391		Proposed	29	3,694.60	0.00	15.0	3,421.92
Polyurethane, MIL-C-85285B, 17925 TY I ~	715	Status Quo	34	3,905.80	0.00	-	-
A-58A Enamel (TT-E-516A)		Proposed	27	2,340.80	0.00	18.0	1,565.00
TT-E-489H Low VOC (15182 Blue)		Proposed	31	2,931.64	0.00	22.5	974.16
Pigmented Polymer ~	715	Status Quo	41	2,663.32	0.00	-	-
A-58A Enamel (TT-E-516A)		Proposed	27	2,340.80	0.00	25.5	322.52
TT-E-489H Low VOC (15182 Blue)		Proposed	31	2,931.64	0.00	33.0	(268.32)
So-Sure Lacquer ~	715	Status Quo	58	2,045.80	0.00	-	-
A-58A Enamel (TT-E-516A)		Proposed	27	2,340.80	0.00	23.0	(295.00)
TT-E-489H Low VOC (15182 Blue)		Proposed	31	2,931.64	0.00	29.0	(885.84)
So-Sure Blue 35109 (54-350)P	715	Status Quo	51	2,122.60	0.00	-	-
A-58A Enamel (TT-E-516A)		Proposed	27	2,340.80	0.00	22.0	(218.20)
TT-E-489H Low VOC (15182 Blue)		Proposed	31	2,931.64	0.00	28.0	(809.04)
So-Sure Yellow 23538 (114-230)G ~	715	Status Quo	67	2,333.80	0.00	-	-
A-58A Enamel (TT-E-516A)		Proposed	27	2,340.80	0.00	0.0	(7.00)
TT-E-489H Low VOC (15182 Blue)		Proposed	31	2,931.64	0.00	13.0	(597.84)
Metallic Topcoats	715	Status Quo	N/A	N/A	N/A	N/A	N/A
Discontinued							
HARD HAT Fluorescent Topcoats ~	715	Status Quo	75	7,691.00	0.00	-	-
Heat Resisting EN-TT-E-496A 14391		Proposed	29	3,694.60	0.00	2.5	3,996.40
A-58A Enamel (TT-E-516A)		Proposed	27	2,340.80	0.00	2.5	5,350.20
TT-E-489H Low VOC (15182 Blue)		Proposed	31	2,931.64	0.00	2.5	4,759.36
PC-118 Polyurethane Curing Solution ~	715	Status Quo	52	6,823.00	0.00	-	-
A-58A Enamel (TT-E-516A)		Proposed	27	2,340.80	0.00	5.0	4,482.20
TT-E-489H Low VOC (15182 Blue)		Proposed	31	2,931.64	0.00	5.0	3,891.36
Aliphatic Polyurethane & Coreactant	715	Status Quo	N/A	N/A	N/A	N/A	N/A
Discontinued							
TY 1 #20117 Brown Air Dry Enamel ~	715	Status Quo	41	6,816.00	0.00	-	-
A-58A Enamel (TT-E-516A)		Proposed	27	2,340.80	0.00	7.5	4,475.20
TT-E-489H Low VOC (15182 Blue)		Proposed	31	2,931.64	0.00	7.5	3,884.36
Epoxy Catalyst ~	715	Status Quo	43	8,316.00	0.00	-	-
Heat Resisting EN-TT-E-496A 14391		Proposed	29	3,694.60	0.00	7.5	4,621.40
A-58A Enamel (TT-E-516A)		Proposed	27	2,340.80	0.00	7.5	5,975.20
TT-E-489H Low VOC (15182 Blue)		Proposed	31	2,931.64	0.00	7.5	5,384.36
Catalyst Aliphatic Isocyanate Reactant ~	715	Status Quo	53	9,635.00	0.00	-	-
A-58A Enamel (TT-E-516A)		Proposed	27	2,340.80	0.00	2.0	7,294.20
Heat Resisting EN-TT-E-496A 14391		Proposed	29	3,694.60	0.00	5.0	5,940.40
TT-E-489H Low VOC (15182 Blue)		Proposed	31	2,931.64	0.00	5.0	6,703.36
KEM TRANSPORT Synthetic Enamel	715	Status Quo	N/A	N/A	N/A	N/A	N/A
Custom-made							

( ) denotes a negative value
HMSF=Hazardous Material Selection Factor
UAC=Uniform Annual Cost
PPPN=Pollution Prevention Priority Number
~ =not a potential alternative

Lakes ID/4R, P/N FLSC-98). Based on this, AFMA utilized the BCR Analysis to further analyze the Nature-Sol 100, manufactured by Brulin and Company, Inc., and the Safety Prep, FD 080, manufactured by Inland Technology, Inc.

6.1.5 Acetone

Buildings 1040 and 715 use approximately the same yearly quantity of Acetone, manufactured by Mallinckrodt Chemical, Inc., for CAD Remanufacture and Inspection/Rework of Rocket Motors, respectively. AFMA conducted the feasibility analyses on six alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 17 (Safety Prep, FD 080) to 56 (Acetone). The discounted costs range from $5418.71 (Nature-Sol 100) to $90755.45 (Brulin SD 1291). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 2 (Nature-Sol 100) to 40 (Finger Lakes ID/4R, P/N FLSC-98). Based on this, AFMA utilized the BCR Analysis to further analyze the Nature-Sol 100, manufactured by Brulin and Company, Inc., and the Safety Prep, FD 080, manufactured by Inland Technology, Inc.

6.1.6 Toluene

Buildings 1190 and 1041 use approximately the same yearly quantity of Toluene, manufactured by Ashland Chemical Company, for Cleaning of Mix Bowl and Cleaning of Cast Tooling, respectively. AFMA conducted the feasibility analyses on six alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 15 (Hurrisafe 9040 Special Formula) to 71 (Toluene). The discounted costs range from $23304.87 (Toluene) to $2125661.64 (Klean-Green Cleaning Solvent). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs in this case were 20 for each of the three products being considered for further analysis, Klean-Strip Mil-Klean, manufactured by W.M. Barr and Company, Inc., Hurrisafe 9040 Special Formula, manufactured by PCI of America, and Safety Prep, FD 080, manufactured by Inland Technology, Inc. Based on this, AFMA utilized the BCR Analysis to further analyze these three products.

6.1.7 Toluene

Building 1190 uses Toluene, manufactured by Ashland Chemical Company, for Daily Cleanup of Mix Blades. AFMA conducted the feasibility analyses on six alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 15 (Hurrisafe 9040 Special Formula) to 71 (Toluene). The discounted costs range from $580.57 (Toluene) to $1817.36 (Klean-Green Cleaning Solvent). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs in this case were 20 for each of the three products being considered for further analysis, Hurrisafe 9040 Special Formula, manufactured by PCI of America, and FC056 Citra Safe and Safety Prep, FD 080, both manufactured by Inland Technology, Inc. Based on this, AFMA utilized the BCR Analysis to further analyze these three products.

6.1.8 Primer

Building 715 uses #1001 Zinc Primer Liquid, manufactured by PPG Industries, Inc., for Motor Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on eight alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 18 (TT-E-545C Alkyd Primer) to 51 (So-Sure Primer Yellow 33637 P/N 782-831). The discounted costs range from $12853.19 (TT-E-545C Alkyd Primer) to $26067.39 (Lacquer Primer MIL-P-7962). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 13 (TT-E-545C Alkyd Primer) to 39 (Lacquer Primer MIL-P-7962). Based on this, AFMA utilized the BCR Analysis to further analyze the TT-E-545C Alkyd Primer, manufactured by Davlin Paint Company, Inc.

6.1.9 MIL-T-81772B Solvent Thinner

Building 715 uses MIL-T-81772B Solvent Thinner, manufactured by DeSoto, Inc., for Motor Paint, MK 37 ASROC and Thruster Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 13 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 23 (TT-T-291E Thinner) to 62 (CSD 81772 Type I A Thinner, Epoxy). The discounted costs range from $3648.06 (Klean-Strip Paint Thinner) to $46725.20 (MIL-T-81772B Solvent Thinner). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 2 (TT-T-291E Thinner) to 3 (TL 102 Thinner, Aliphatic, Polyurethane; Chevron Thinner 350 H; Klean-Strip Mineral Spirits PN-GMS44). Based on this, AFMA utilized the BCR Analysis be utilized analyze the TT-T-291E Thinner, manufactured by Atlas Paint and Varnish Company.

6.1.10 CHEMGLAZE 9951 Thinner

Building 715 uses CHEMGLAZE 9951 Thinner, manufactured by Lord Corp Chemical Products, for Motor Paint, MK 37 ASROC and Thruster Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 13 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 23 (TT-T-291E Thinner) to 62 (CSD 81772 Type I A Thinner, Epoxy). The discounted costs range from $3648.06 (Klean-Strip Paint Thinner) to $18161.91 (CHEMGLAZE 9951 Thinner). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 2 (TT-T-291E Thinner) to 7.5 (TL 102 Thinner, Aliphatic, Polyurethane; Klean-Strip Mineral Spirits PN-GMS44). Based on this, AFMA utilized the BCR Analysis to further analyze the TT-T-291E Thinner, manufactured by Atlas Paint and Varnish Company, and the Chevron Thinner 350 H, manufactured by Chevron Environmental Health Center.

6.1.11 Thinner Synthetic Resin Enamel

Building 715 uses Thinner Synthetic Resin Enamel, manufactured by CSD, Inc., for Motor Paint, MK 37 ASROC and Thruster Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 13 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 23 (TT-T-291E Thinner) to 62 (CSD 81772 Type I A Thinner, Epoxy). The discounted costs range from $3648.06 (Klean-Strip Paint Thinner) to $7386.93 (T-81772 Type 2 Epoxy Thinner). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 21 (TT-T-291E Thinner; Chevron Thinner 350 H) to 33 (TL 102 Thinner, Aliphatic, Polyurethane). Based on this, AFMA utilized the BCR Analysis to further analyze the TT-T-291E Thinner, manufactured by Atlas Paint and Varnish Company, and the Chevron Thinner 350 H, manufactured by Chevron Environmental Health Center.

6.1.12 Mineral Spirits

Building 715 uses Mineral Spirits, manufactured by CSD, Inc., for Motor Paint, MK 37 ASROC and Thruster Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 13 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 23 (TT-T-291E Thinner) to 62 (CSD 81772 Type I A Thinner, Epoxy). The discounted costs range from $3346.32 (Mineral Spirits) to $7386.93 (T-81772 Type 2 Epoxy Thinner). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 24 (TT-T-291E Thinner) to 60 (TL 102 Thinner, Aliphatic, Polyurethane; Klean-Strip Mineral Spirits, PN-GMS44). Based on this, AFMA utilized the BCR Analysis to further analyze the TT-T-291E Thinner, manufactured by Atlas Paint and Varnish Company.

6.1.13 Krylon High Heat Spray Paint

Building 715 uses Krylon High Heat Spray Paint, manufactured by Division of Borden, for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 21 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 27 (A-58A Enamel (TT-E-516A)) to 60 (Polyurethane High Solids Black 37038, Parts 1 and 2). The discounted costs range from $16440.84 (A-58A Enamel (TT-E-516A)) to $435987.16 (MIL-P-23377F Epoxy TY 1, Cl 2 513X419). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 18 (A-58A Enamel (TT-E-516A)) to 54 (Polyurethane Coating, Black 17038, Parts 1 and 2). Based on this, AFMA utilized the BCR Analysis to further analyze the A-58A Enamel (TT-E-516A), manufactured by Koppers Company, and the TT-E-489H Low VOC (15182 Blue), manufactured by Kop-Coat, Inc.

6.1.14 Krylon 1402 High Heat Aluminum Paint

Building 715 uses Krylon 1402 High Heat Aluminum Paint, manufactured by Division of Borden, for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 21 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 27 (A-58A Enamel (TT-E-516A)) to 60 (Polyurethane High Solids Black 37038, Parts 1 and 2). The discounted costs range from $16440.84 (A-58A Enamel (TT-E-516A)) to $435987.16 (MIL-P-23377F Epoxy TY 1, Cl 2 513X419). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 18 (A-58A Enamel (TT-E-516A)) to 54 (Polyurethane Coating, Green 24052, Parts 1 and 2). Based on this, AFMA utilized the BCR Analysis to further analyze the A-58A Enamel (TT-E-516A), manufactured by Koppers Company, and the TT-E-489H Low VOC (15182 Blue), manufactured by Kop-Coat, Inc.

6.1.15 Epoxy, MIL-P-85582B, TY 1 Cl C1

Building 715 uses Epoxy, MIL-P-85582B, TY 1 Cl C1, manufactured by Deft, Inc., for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 21 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 27 (A-58A Enamel (TT-E-516A)) to 60 (Polyurethane High Solids Black 37038, Parts 1 and 2). The discounted costs range from $16440.84 (A-58A Enamel (TT-E-516A)) to $435987.16 (MIL-P-23377F Epoxy TY 1, Cl 2 513X419). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 7.5 (A-58A Enamel (TT-E-516A); Heat Resisting EN-TT-E-496A 14391; TT-E-489H Low VOC (15182 Blue)) to 24 (Polyurethane Coating, Green 24052, Parts 1 and 2). Based on this, AFMA utilized the BCR Analysis to further analyze the A-58A Enamel (TT-E-516A), manufactured by Koppers Company, the Heat Resisting EN-TT-E-496A 14391, manufactured by Warren Paint and Color Company, and the TT-E-489H Low VOC (15182 Blue), manufactured by Kop-Coat, Inc.

6.1.16 Aliphatic Isocyanate

Building 715 uses Aliphatic Isocyanate, manufactured by Deft, Inc., for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 21 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 27 (A-58A Enamel (TT-E-516A)) to 60 (Polyurethane High Solids Black 37038, Parts 1 and 2). The discounted costs range from $16440.84 (A-58A Enamel (TT-E-516A)) to $435987.16 (MIL-P-23377F Epoxy TY 1, Cl 2 513X419). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 7.5 (A-58A Enamel (TT-E-516A); TT-E-489H Low VOC (15182 Blue)) to 26 (Polyurethane Coating, Black 17038, Parts 1 and 2). Based on this, AFMA utilized the BCR Analysis to further analyze

the A-58A Enamel (TT-E-516A), manufactured by Koppers Company, the Heat Resisting EN-TT-E-496A 14391, manufactured by Warren Paint and Color Company, and the TT-E-489H Low VOC (15182 Blue), manufactured by Kop-Coat, Inc.

6.1.17 Polyurethane, MIL-C-85285B, 17925 TY I

Building 715 uses MIL-C-85285B, 17925 TY I, manufactured by Deft, Inc., for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 21 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 27 (A-58A Enamel (TT-E-516A)) to 60 (Polyurethane High Solids Black 37038, Parts 1 and 2). The discounted costs range from $16440.84 (A-58A Enamel (TT-E-516A)) to $435987.16 (MIL-P-23377F Epoxy TY 1, Cl 2 513X419). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 18 (A-58A Enamel (TT-E-516A)) to 50 (Polyurethane Coating, Green 24052, Parts 1 and 2). Based on this, AFMA utilized the BCR Analysis to further analyze the A-58A Enamel (TT-E-516A), manufactured by Koppers Company, and the TT-E-489H Low VOC (15182 Blue), manufactured by Kop-Coat, Inc.

6.1.18 Pigmented Polymer

Building 715 uses Pigmented Polymer, manufactured by Chemray Coatings Corp., for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 21 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 27 (A-58A Enamel (TT-E-516A)) to 60 (Polyurethane High Solids Black 37038, Parts 1 and 2). The discounted costs range from $16440.84 (A-58A Enamel (TT-E-516A)) to $435987.16 (MIL-P-23377F Epoxy TY 1, Cl 2 513X419). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 25.5 (A-58A Enamel (TT-E-516A)) to 60 (Polyurethane Coating, Green 24052, Parts 1 and 2; Polyurethane Coating, Black 37038, Parts 1 and 2). Based on this, AFMA utilized the BCR Analysis to further analyze the A-58A Enamel (TT-E-516A), manufactured by Koppers Company, and the TT-E-489H Low VOC (15182 Blue), manufactured by Kop-Coat, Inc.

6.1.19 So-Sure Lacquer

Building 715 uses So-Sure Lacquer, manufactured by LHB Industries, for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 21 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 27 (A-58A Enamel (TT-E-516A)) to 60 (Polyurethane High Solids Black 37038, Parts 1 and 2). The discounted costs range from $14368.88 (So-Sure Lacquer) to $435987.16 (MIL-P-23377F Epoxy TY 1, Cl 2 513X419). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 23 (A-58A Enamel (TT-E-516A)) to 60 (Polyurethane Coating, Green 24052, Parts 1 and 2; Polyurethane Coating, Black 37038, Parts 1 and 2; Polyurethane High Solids, Black 37038, Parts 1 and 2; Polyurethane Coating, Black 17038, Parts 1 and 2). Based on this, AFMA utilized the BCR Analysis to further analyze the A-58A Enamel (TT-E-516A), manufactured by Koppers Company, and the TT-E-489H Low VOC (15182 Blue), manufactured by Kop-Coat, Inc.

6.1.20 So-Sure Blue 35109 (54-350) P

Building 715 uses So-Sure Blue 35109 (54-350) P, manufactured by LHB Industries, for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 21 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 27 (A-58A Enamel (TT-E-516A)) to 60 (Polyurethane High Solids Black 37038, Parts 1 and 2). The discounted costs range from $14908.29 (So-Sure Blue 35109 (54-350) P) to

$435987.16 (MIL-P-23377F Epoxy TY 1, Cl 2 513X419). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 22 (A-58A Enamel (TT-E-516A)) to 80 (Polyurethane High Solids, Black 37038, Parts 1 and 2). Based on this, AFMA utilized the BCR Analysis to further analyze the A-58A Enamel (TT-E-516A), manufactured by Koppers Company, and the TT-E-489H Low VOC (15182 Blue), manufactured by Kop-Coat, Inc.

6.1.21 So-Sure Yellow 23538 (114-230) G

Building 715 uses So-Sure Yellow 23538 (114-230) G, manufactured by LHB Industries, for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 21 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 27 (A-58A Enamel (TT-E-516A)) to 67 (So-Sure Yellow 23538 (114-230) G). The discounted costs range from $16391.68 (So-Sure Yellow 23538 (114-230) G) to $435987.16 (MIL-P-23377F Epoxy TY 1, Cl 2 513X419). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 0 (A-58A Enamel (TT-E-516A)) to 60 (Polyurethane Coating, Black 17038, Parts 1 and 2). Based on this, AFMA utilized the BCR Analysis to further analyze the A-58A Enamel (TT-E-516A), manufactured by Koppers Company, and the TT-E-489H Low VOC (15182 Blue), manufactured by Kop-Coat, Inc.

6.1.22 Metallic Topcoats

Building 715 uses Metallic Topcoats, manufactured by Rust-Oleum Corporation, for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. However, this product has been discontinued. No information was collected and the feasibility analyses were not performed.

6.1.23 HARD HAT Fluorescent Topcoats

Building 715 uses HARD HAT Fluorescent Topcoats, manufactured by Rust-Oleum Corporation, for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 21 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 27 (A-58A Enamel (TT-E-516A)) to 75 (HARD HAT Fluorescent Topcoats). The discounted costs range from $16440.84 (A-58A Enamel (TT-E-516A)) to $435987.16 (MIL-P-23377F Epoxy TY 1, Cl 2 513X419). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 2.5 (A-58A Enamel (TT-E-516A); Heat Resisting EN-TT-E-496A 14391; TT-E-489H Low VOC (15182 Blue)) to 18 (Polyurethane High Solids, Black 37038, Parts 1 and 2). Based on this, AFMA utilized the BCR Analysis to further analyze the A-58A Enamel (TT-E-516A), manufactured by Koppers Company, the Heat Resisting EN-TT-E-496A 14391, manufactured by Warren Paint and Color Company, and the TT-E-489H Low VOC (15182 Blue), manufactured by Kop-Coat, Inc.

6.1.24 PC-118 Polyurethane Curing Solution

Building 715 uses PC-118 Polyurethane Curing Solution, manufactured by Crown Metro Aerospace, for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 21 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 27 (A-58A Enamel (TT-E-516A)) to 60 (Polyurethane High Solids Black 37038, Parts 1 and 2). The discounted costs range from $16440.84 (A-58A Enamel (TT-E-516A)) to $435987.16 (MIL-P-23377F Epoxy TY 1, Cl 2 513X419). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 5 (A-58A Enamel (TT-E-516A); TT-E-489H Low VOC (15182 Blue)) to 21 (Polyurethane Coating, Green 24052, Parts 1 and 2; Polyurethane Coating, Black 17038,

Parts 1 and 2). Based on this, AFMA utilized the BCR Analysis to further analyze the A-58A Enamel (TT-E-516A), manufactured by Koppers Company, and the TT-E-489H Low VOC (15182 Blue), manufactured by Kop-Coat, Inc.

6.1.25 Aliphatic Polyurethane and Coreactant

Building 715 uses Aliphatic Polyurethane and Coreactant, manufactured by Randolph Products Company, for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. However, this product has been discontinued. No information was collected and the feasibility analyses were not performed.

6.1.26 TY 1 #20117 Brown Air Dry Enamel

Building 715 uses TY 1 #20117 Brown Air Dry Enamel, manufactured by Randolph Products Company, for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 21 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 27 (A-58A Enamel (TT-E-516A)) to 60 (Polyurethane High Solids Black 37038, Parts 1 and 2). The discounted costs range from $16440.84 (A-58A Enamel (TT-E-516A)) to $435987.16 (MIL-P-23377F Epoxy TY 1, Cl 2 513X419). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 7.5 (A-58A Enamel (TT-E-516A); TT-E-489H Low VOC (15182 Blue)) to 21 (Polyurethane Coating, Green 24052, Parts 1 and 2; Polyurethane Coating, Black 17038, Parts 1 and 2). Based on this, AFMA utilized the BCR Analysis to further analyze the A-58A Enamel (TT-E-516A), manufactured by Koppers Company, and the TT-E-489H Low VOC (15182 Blue), manufactured by Kop-Coat, Inc.

6.1.27 Epoxy Catalyst

Building 715 uses Epoxy Catalyst, manufactured by Randolph Products Company, for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 21 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 27 (A-58A Enamel (TT-E-516A)) to 60 (Polyurethane High Solids Black 37038, Parts 1 and 2). The discounted costs range from $16440.84 (A-58A Enamel (TT-E-516A)) to $435987.16 (MIL-P-23377F Epoxy TY 1, Cl 2 513X419). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 7.5 (A-58A Enamel (TT-E-516A); Heat Resisting EN-TT-E-496A 14391; TT-E-489H Low VOC (15182 Blue)) to 22 (Polyurethane Coating, Black 17038, Parts 1 and 2). Based on this, AFMA utilized the BCR Analysis to further analyze the A-58A Enamel (TT-E-516A), manufactured by Koppers Company, the Heat Resisting EN-TT-E-496A 14391, manufactured by Warren Paint and Color Company, and the TT-E-489H Low VOC (15182 Blue), manufactured by Kop-Coat, Inc.

6.1.28 Catalyst Aliphatic Isocyanate Reactant

Building 715 uses Catalyst Aliphatic Isocyanate Reactant, manufactured by Randolph Products Company, for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. AFMA conducted the feasibility analyses on 21 alternatives. Based on the results of the analyses performed utilizing the P2 System, the HMSFs range from 27 (A-58A Enamel (TT-E-516A)) to 60 (Polyurethane High Solids Black 37038, Parts 1 and 2). The discounted costs range from $16440.84 (A-58A Enamel (TT-E-516A)) to $435987.16 (MIL-P-23377F Epoxy TY 1, Cl 2 513X419). After careful consideration of the results obtained, AFMA performed the PPPN Analysis on the most promising pollution prevention alternatives. The PPPNs range from 2 (A-58A Enamel (TT-E-516A)) to 15 (Polyurethane Coating, Green 24052, Parts 1 and 2; Polyurethane Coating, Black 17038, Parts 1 and 2). Based on this, AFMA utilized the BCR Analysis to further analyze the A-58A Enamel (TT-E-516A), manufactured by Koppers

Company, the Heat Resisting EN-TT-E-496A 14391, manufactured by Warren Paint and Color Company, and the TT-E-489H Low VOC (15182 Blue), manufactured by Kop-Coat, Inc.

6.1.29 KEM TRANSPORT Synthetic Enamel

Building 715 uses KEM TRANSPORT Synthetic Enamel, manufactured by The Sherwin Williams Company, for Paint/Stencil/Packout Vandal Chambers and Motor Paint, MK 37 ASROC. However, this product is custom made for the customer. Because specific information regarding this product was not collected, the feasibility analyses were not performed.

6.2 Conclusions

AFMA performed on-site value engineering studies on 13 hazardous material uses identified at IHD. To accomplish this task, AFMA conducted economic and risk analyses via the P2 System, and performed the market availability studies, the PPPN Analysis and the BCR Analysis on the status quo alternatives and on the pollution prevention alternatives developed. AFMA compared the baseline information collected on-site against the pollution prevention alternatives recommended for implementation at IHD. In doing so, AFMA determined the feasibility of utilization of the P2 System for conducting pollution prevention alternative assessments, as described in this final Technical Report.

As previously determined in the final Task 1 Technical Report, the HSMS used alone did not prove to be a viable tool for conducting pollution prevention alternative assessments at small non-industrial type Naval facilities. This system was primarily designed to provide "cradle-to-grave" tracking of hazardous materials and hazardous wastes and their chemical constituents as they move through the *procure-store-move-issue-use-discard/recover* cycle. However, used in conjunction with the P2 System, the HSMS provided the status quo alternative information necessary for conducting the required economic and risk analyses.

The NAVFAC P-442 Economic Analysis Model, utilized from within the P2 System, assisted in evaluating potential pollution prevention alternatives to an extent. The hazardous material uses analyzed on-site were fairly basic, and a limited amount of cost data was obtained from IHD. Despite this, AFMA incorporated the available data into the Model and made a number of valid assumptions, which permitted a simple comparison of the status quo alternatives to the pollution prevention alternatives developed.

The HM Substitution Process, also utilized from within the P2 System, proved to be a valuable tool for evaluating pollution prevention alternatives. This Process allowed for the simple and straightforward calculation of the HMSF, which was the most important indicator of each material's environmental, safety and health benefits. While a number of sound assumptions were made to calculate the HMSF for the status quo alternatives and for the pollution prevention alternatives being considered for possible implementation at IHD, AFMA is confident that these assumptions did not affect the validity of the results of the risk analyses performed.

The market availability studies proved to be a viable tool by which feasible pollution prevention alternatives were developed and their availability and associated costs were identified. These studies also assisted with the value engineering studies by providing the additional guidance necessary for ranking the pollution prevention alternatives for further analysis utilizing the PPPN Analysis and the BCR Analysis. However, as stated previously, the fundamental guidance necessary for performing the market availability studies is not available, and as a result, AFMA's performance of these studies was limited to a first-order level of effort.

The P2 System proved to be the most valuable tool by which AFMA conducted the feasibility analyses. The results of the economic and risk analyses performed through utilization of this system provided the strongest evidence to support the further analysis of 32 of the 79 pollution prevention alternatives initially identified. However, AFMA suggests that the recommended changes and/or

additions noted in this Technical Report be incorporated into the P2 System, such that the resulting output reports generated are both accurate and detailed.

The PPPN Analysis proved to be a viable tool for further analyzing the 32 most promising pollution prevention alternatives in terms of their environmental, safety and health benefits. This analysis also assisted with the prioritization of these alternatives, which was necessary for identifying the 18 pollution prevention alternatives to undergo one final analysis, for ultimate recommendation as the optimum value pollution prevention alternatives. AFMA used this approach to successfully analyze the alternatives from a pollution prevention per dollar angle. Clearly, an option that offered more pollution prevention per dollar was recommended for implementation at IHD.

The BCR Analysis provided an unbiased representation of the benefits versus cost implications of the most promising the pollution prevention alternatives being considered for possible implementation at IHD. After careful review of all data, AFMA computed the BCR for the 18 most promising pollution prevention alternatives in terms of Direct Cost Savings benefits. This analysis proved to be a successful tool for assisting IHD in achieving the most beneficial resource allocation with regard to implementing the most promising alternatives, based on the results obtained.

Based on the results of the analyses conducted, as presented in this final Technical Report, AFMA recommends 11 optimum value pollution prevention alternatives for implementation at IHD. Figure 2 displays the annual cost savings, $8,322.86, to be achieved at IHD upon implementation of these pollution prevention alternatives. These material substitutes are considered feasible substitutes that are both cost-effective and environmentally-sound. AFMA believes that an initiative of this nature will aid the Navy in its mission to prevent pollution, protect the environment, and protect natural resources by preventing or reducing pollution at the source.

	Product	Bldg.	Alternative	UAC ($)		Direct Cost Benefit ($)
	SS-4004 Silicone Primer	292	Status Quo	634.00		[1]
1	NONE		Proposed	-		0
	MS-143 Fluorocarbon Relesae Agent	292	Status Quo	612.80		-
2	Release #1 VOC		Proposed	87.62	$	525.18
	A-12 Parts A and B Adhesive	720	Status Quo	1,904.50		-
3	PSI-367 Parts A & B Epoxy Paste		Proposed	317.90	$	1,586.60
	Acetone	720, 160	Status Quo	586.45		-
4	Safety Prep, FD 080		Proposed	579.95	$	6.50
	Acetone	1040, 715	Status Quo	4,904.80		-
4	Safety Prep, FD 080		Proposed	5,069.80	$	(165.00)
	Toluene (Cleaning of Mix Bowl/Cast Tooling)	1190, 1041	Status Quo	3,318.08		-
5	Klean-Strip Mil-Klean		Proposed	8,013.40	$	(4,695.32)
	Toluene (Daily Cleanup of Mix Blades)	1190	Status Quo	82.66		-
6	Hurrisafe 9040 Special Formula		Proposed	152.72	$	(70.06)
	#1001 Zinc Primer Liquid	715	Status Quo	2,846.20		-
7	TT-E-545C Alkyd Primer		Proposed	2,344.60	$	501.60
	MIL-T-81772B Solvent Thinner	715	Status Quo	6,652.60		-
8	TT-T-291E Thinner		Proposed	557.80	$	6,094.80
	CHEMGLAZE 9951 Thinner	715	Status Quo	2,585.84		-
8	TT-T-291E Thinner		Proposed	557.80	$	2,028.04
	Thinner Synthetic Resin Enamel	715	Status Quo	765.40		-
8	TT-T-291E Thinner		Proposed	557.80	$	207.60
	Mineral Spirits	715	Status Quo	476.44		-
8	TT-T-291E Thinner		Proposed	557.80	$	(81.36)
	All Status Quo Alternatives (average value)[2]	715	Status Quo	5373.29		-
9-11	Three proposed alternatives (average value)		Proposed	2989.01	$	2,384.28
				Total Annual Savings	$	8,322.86

( ) denotes a negative value

1 - Status Quo recommended over pollution prevention alternatives based on environmental impacts

2 - More than one Status Quo sharing common Pollution Prevention Alternatives

Figure 2
Annual Cost Savings Pending Implementation
of the Pollution Prevention Alternatives